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A CONTRIBUTION TO THE MORPHOLOGY AND DEVELOPMENT OF CORYMORPHA PENDULA AG.

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THE following paper on the morphology and development of *Corymorpha pendula* was undertaken at the suggestion of Dr. C. W. Hargitt, for whose kindly criticism and suggestions throughout its progress it is a pleasure to express my obligation.

The purpose of these observations is to investigate some of the more fundamental morphological features of this hydroid; to trace the origin and development of the Medusa and to inquire briefly into the origin of the sex cells and the phenomena associated with oögenesis.

Corymorpha, in all the synopses of the Hydroidea which I have examined, is described as a solitary form, but in the material which was placed at my disposal, my attention was early called to the presence of what appeared to be definite colonial buds arising from the hydrorhiza. Acting upon the suggestion of Dr. Hargitt that it might be an interesting problem to determine whether these associated forms were true buds or mere parasites, I have begun my study with an investigation of the nature and relation of these forms.

Methods. — The specimens at my disposal were collected by Dr. C. W. Hargitt at Wood's Holl, Mass., during the summer of 1900. Several methods of killing and preserving were used. My best results were obtained from material killed in corrosive acetic acid. Formalin and Flemming's solution gave less satisfactory results.

In the study of general histological features I found that *in toto* staining in borax carmine was both a satisfactory and convenient method. Specimens might be left in the stain from 10 to 48 hours and then the stain extracted to any desired degree in 1% acid-alcohol. Dehydration required from one to two hours. For clearing, cedar oil, clove oil, xylol or turpentine were used; xylol or turpentine proving most satisfactory.

In the study of the developmental features a number of sections were stained on the slide with iron-hæmatoxylin. Combinations of iron-hæmatoxylin and Bordeaux red, and of eosin and hæmatoxylin were used with good success.

In the former combination sections were placed in a 2% solution of ammonio-ferric-alum for from thirty minutes to four hours. After this they were washed for several minutes in running water and then stained in a 5% aqueous solution of hæmatoxylin for from one to three hours. They were then again washed in running water and again treated with the iron solution, which slowly washed out the stain, until a satisfactory differentiation was obtained. After rinsing the sections in water they were stained from fifteen minutes to one half hour in Bordeaux red, carried up through the alcohols and mounted in balsam.

In the eosin-hæmatoxylin method sections were first stained from one to two hours in a 2% solution of alcoholic eosin and then from five to fifteen minutes in a weak solution of Delafield's hæmatoxylin.

Associated forms. — As stated in the introduction, one of the first things that was called to my attention in taking up the study of the morphology of *Corymorpha pendula*, was the presence of a smaller hydroid associated with it. These smaller forms have all the appearance of true buds. In some cases they are found attached to the hydrocaulis, and in others they are observed springing up from within the tangled network of rhizoidal fila-

ments. Wishing to discover something as to the true relations of these forms, I made a series of transections of the stem of Corymorpha in the region of these supposed buds in order to determine whether, in the first place, there was any organic connection between them. A study of these sections revealed no such organic connection whatsoever. The base of the smaller hydroid was in all cases buried only in the perisarc of Corymorpha and generally separated from the ectodermal layer by a considerable thickness of perisarc.

Upon taking off some small portions of the perisarc of Corymorpha bearing these supposed buds, staining with borax-carmine and mounting whole, a peculiar modification of the base of these smaller hydroids was observed. The stem after it has penetrated the perisarc for a short distance, expands and gives off a number of lateral finger like projections extending through the perisarc in various directions.

Further examination also proved that the stem is annulated for a considerable portion of its length and that the cœnosarcal canals so characteristic of Corymorpha are entirely lacking.

From these observations it is quite clearly evident that we have here distinct forms instead of true colonial buds, thus confirming the usual descriptions of Corymorpha as a solitary form.

This species, however, I have not been able to find described in any of the synopses of the Hydroidea. From its morphology it is evidently a tubularian. Dr. Hargitt has suggested for the species the name *parasitica,* and as such it has recently been described by him. Torrey (:02) has expressed the opinion that these forms are undoubtedly clusters of young individuals of Corymorpha. This view would seem to be precluded not only from a consideration of their morphological characteristics, but from the fact that all the specimens examined were of about the same size, and some of them even began to show signs of sexual maturity.

Corymorpha pendula.

External Morphology. — L. Agassiz ('62, p. 276) says, "This hydroid is not found along our shores as are the other tubularians, but may be obtained by dredging in deeper water on a

sandy or muddy bottom. In some localities it is quite plentiful. It has been collected in three different places, all within Massachusetts bay." Specimens have been taken off "Crab Ledge," Chatham, in the deep waters of Muskeget Channel and in Vineyard Sound. The natural position of this hydroid is an upright one. Hargitt (:01, p. 313) describes this hydroid as "bright pink in color, medusæ light yellowish, manubrium, tentacles and bulbs pinkish."

Corymorpha is always found as a solitary form, never budding nor giving rise to colonies. The stems grow to a height of from six to ten centimeters and reach a maximum diameter just a little above the proximal extremity. Toward both extremities, the diameter decreases; the stem tapering gradually toward the distal end, where it terminates in a short blunt point. The stem is invested in a very delicate, filmy, colorless perisarc, which in the upper region of the stem is very closely applied, but below becomes separated from it by a very considerable space, forming here a sort of loose fitting corrugated sac over the blunt point of the basal extremity. The stem is seen to be traversed by a series of longitudinal bands which anastomose with one another here and there, and which represent, as we shall see later, a series of canals hollowed out in the entoderm. From the lower region of the stem there grows out a large number of short papilliform processes. The hydrorhiza consists of a tangled network of numerous thread-like filaments.

The hydranth is somewhat flask shaped, the neck of the flask being represented by the flexible proboscis at the distal extremity of the hydranth. In the centre of this proboscis is found the mouth surrounded by from seventy-five to eighty-five closely set tentacles arranged in a number of irregular whorls, and having somewhat the appearance of a brush. About the base of the hydranth is a single circle of very much larger tentacles varying in number from twenty-five to thirty.

The medusoids are arranged in closely crowded clusters borne upon slender branched pedicels which arise from the body of the hydranth immediately above the proximal set of tentacles. There are from fifteen to twenty-five of these medusoid-bearing branches.

Histology of Parts.

(*a.*) *Hydrocaulis.* — The perisarc: — The perisarc presents the appearance of a thin, semi-transparent film. This film is considerably thicker about the basal portion of the stem than it is in the distal region where it becomes so thin and delicate as to be almost lost to sight.

Ectoderm: — The ectoderm, although its cellular structure was not especially well defined in some sections, is composed of a single layer of somewhat columnar cells with large and distinct nuclei, and filled with numerous granules. Among the cells of the ectoderm are to be found great numbers of small transparent cells, the developing nematocysts. These nematocysts seem to be most numerous and best developed in the tentacles.

Entoderm: — The entoderm is composed of two distinctly different kinds of cells whose disposition through the stem may be best understood by calling attention here to the peculiar modification which Corymorpha presents as regards the enteric cavity. In most hydroids this is represented by a hollow cœnosarc, its tubular cavity being central in position and communicating directly with the cavities of the polypes. In Corymorpha, however, this cavity is represented by a number of intercommunicating canals running longitudinally through the entire length of the stem. (Fig. 1, *m.*) The whole central axis of the stem is occupied by a column of parenchyma-like tissue composed of large, loose, vacuolated cells of an irregular polygonal shape. (Fig. 1, *a.*) These cells have very little contents with the exception of here and there a number of small nuclear corpuscles. Torrey (:02) refers to these entodermal cells as "skeletal cells"; and, as he suggests, this condition of peripheral canals and a solid entodermal axis, would seem to be, in view of the large diameter of Corymorpha, a "direct adaptation to size." The very delicate character of these cells might make the propriety of the term "skeletal" somewhat questionable. It seems quite probable, nevertheless, that these parenchyma-like cells do afford some support to the stem, but rather by imparting to it a sort of

turgescence, than because they serve as a true, supporting skeletal framework.

The peripheral layer of entoderm, on the other hand, is composed of small sub-spherical cells filled with granular contents and possessing distinct nuclei. (Fig. 1, *b*.)

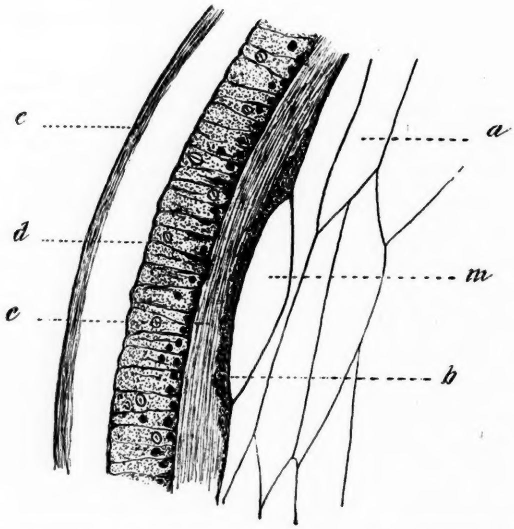

FIG. 1. Transection of stem of Corymorpha showing one of the cœnosarcal canals at *m*; *a*, inner layer of entoderm; *b*, peripheral layer of entoderm; *c*, mesoglœa; *d*, ectoderm; *e*, perisarc.

It is in a zone between these two kinds of entodermal cells that the longitudinal canals are excavated. These canals are simple tubular spaces lying between some of the entoderm cells and entirely devoid of anything like a specially differentiated wall. Above, these canals pursue their course through a cone like projection of the loose entoderm cells which extends for a considerable distance into the cavity of the hydranth proper. (Fig. 2, *a*.) Because of the lacunar nature of these canals, their course through the entoderm cone is somewhat indefinite. At the base of the cone, the canals converge and finally empty into a single median canal which is continued upwards to the apex of the cone. (Fig. 2, *b*.) I have not been able to get sections

which show satisfactorily the course of this median canal, but I am inclined to think that it is continued up through the apex of the cone, thus finally communicating directly with the hydranth cavity.

Towards the base of the stem these canals become fewer and larger by union with each other, but finally disappear in a region just a little below the belt of papillæ.

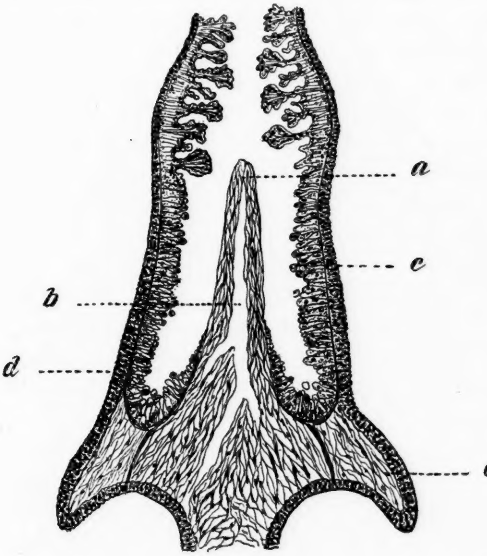

FIG. 2. Longitudinal section of hydranth showing core of entodermal cells at *a*, through which pass the longitudinal canals, *b*; *c*, gland cells of entoderm; *d*, ectoderm; *e*, tentacle.

For the purpose of comparison a series of transverse and of longitudinal sections of *Tubularia couthouyi* were made, and here was found a structure which in all essential features resembles what we have described in Corymorpha. The canals of Tubularia, however, are distinctly wedge shaped in transection with the apex of the wedge directed toward the center of the stem. In Corymorpha, the canals are oval or elliptical in transection. Moreover in Tubularia, the pith like core occupying the center of the stem is composed of small nearly spherical

cells well filled with granular contents. There is no projection of the entodermal axis into the hydranth cavity as we found in Corymorpha.

A number of sections of *Tubularia larynx* were examined for further comparison. The structure of this species agrees in considerable detail with that of *T. couthouyi*.

Allman ('71, p. 205) describes a similar condition in *Tubularia indivisa*. He says: "The stem of Tubularia indivisa presents immediately within the perisarcal tube a continuous layer of ectoderm enclosing the endoderm, which extends to the very center of the stem and thus obliterates all trace of a central somatic cavity. The place of the cavity however is supplied by numerous canals which are excavated in the endoderm and take a longitudinal course through the stem, occasionally communicating by lateral offsets with one another and finally all merging in a common central cavity at the base of the hydranth." He further states that the canals are of unequal size, "one of them especially being in almost every instance considerably larger than any of the others." L. Agassiz ('62) says that a similar condition as to the size of the canals may sometimes be detected in *T. couthouyi*, although I was unable in my observations to perceive any appreciable difference in size.

(*b*.) *Papilliform processes*.—The lower part of the stem of Corymorpha is covered with numerous short conical papillæ arranged in an irregular longitudinal series and apparently following the course of the canals. Lower down toward the base of the stem these papillæ increase in length and in many specimens these small processes were seen in all stages varying from very short blunt papillæ above, to extremely elongate filaments below. Immediately below these processes are found the numerous filamentary rhizoids which cover the saccular portion of the perisarc. The presence of these two structures at the base of the stem and the apparent merging of the one into the other naturally suggests the problem as to their relation and derivation. Upon examination of transections of the stem in this region we find that these papillæ begin as simple outgrowths of the ectoderm. (Fig. 3.) At the same time the mesogloea directly underneath these outgrowths is seen to grow very much thinner, and

in the course of development, to extend up into the papilla for a short distance as seen in Fig. 4 *c*. As the layer of mesoglœa is thus interrupted, the peripheral entodermal cells extend up into the papilla, forming a central axis of entoderm. L. Agassiz ('62) states that these papillæ are hollow and are permeated by prolongations of the chymiferous tubes of the stem. Allman ('71, p. 209) in a description of *C. nutans*, modifies this statement somewhat and says, "They *apparently* communicate with

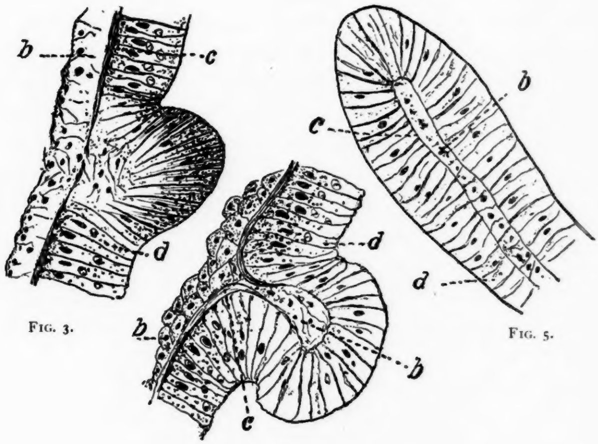

Fig. 3.

Fig. 5.

Fig 4.

Figs. 3, 4, 5 : — Successive stages in the development of the papilliform processes : *b*, entoderm ; *c*, mesoglœa ; *d*, ectoderm.

the canal over which they lie." From a study of a number of sections I have been unable to verify this statement of Agassiz. Not only do the papillæ very often lie in regions other than over the chymiferous canals — I have frequently found them growing out of an area of the stem between two canals — but all of the sections show the papillæ to be solid, composed of an ectoderm and a central core of entoderm. They are not hollow, but maintain this solid character even after they have grown into comparatively long filaments. (Fig. 5.)

As these papillæ continue to grow and elongate, they finally

break through the perisarc; a perisarcal sheath begins to be secreted about them, and their cellular structure becomes less distinct. As the hydroid now continues to grow, the perisarc, which in the younger stage was somewhat closely applied to the base, now becomes separated from it by a considerable distance, forming a loose corrugated sac over the proximal end. With the withdrawal of the coenosarc, the papillæ also sever their connection with the coenosarc. The living cellular portion now being separated from that of the main stem and hence devoid of any means of nourishment, disintegrates, leaving merely a hollow perisarcal tube in its place. Upon examining sections of the filamentary rhizoids, we find that they are mere hollow tubes of perisarc, terminating in an imperforate and somewhat clavate extremity. There thus seems to be no doubt that these rhizoids are but the products of secretion of the papilliform processes.

Allman. ('71, p. 209) referring to them says that these processes "have never been seen to act as organs of adhesion nor have we yet any evidence of the office they may serve in the economy of the animal, but it is impossible not to recognize in them structures having a close relation to the filaments of attachment which are given off from the stem a little lower down."

(*c.*) *Hydranth.*— The most striking histological feature of the hydranth is the presence of numerous and highly developed gland cells (Figs. 6, 7). The development of this remarkably specialized structure leaves little doubt that the function of digestion devolves especially upon this part of the hydroid cavity and that there are here structures set apart for the distinct purpose of secreting the digestive fluid. In the distal part of the hydranth cavity, the entoderm is thrown into a series of large and complicated folds or ridges whose surfaces are covered with these digestive gland cells. In the intervals between the ridges are often found smaller and less numerous cells whose protoplasm takes a denser stain than that of the surrounding cells. The free ends of the gland cells are seen projecting out into the hydranth cavity where their walls may often be seen ruptured and their contents sloughing off into the cavity of the hydranth. (Fig. 6, *a.*) Often the gland cells may be seen entirely separated

from the parent tissue and projected bodily into the hydranth cavity. (Fig. 6, *b*). Toward the center and base of the hydranth cavity, the folds of the entoderm disappear, but the gland cells become decidedly larger and are found covering a considerable portion of the pith-like core which projects into the cavity as described above. The cells in this region are more elongated, with their broad ends projecting into the digestive cavity; the outer ends are rather narrow and tapering, and become merged in the converging ends of the neighboring cells. (Fig. 6.) These

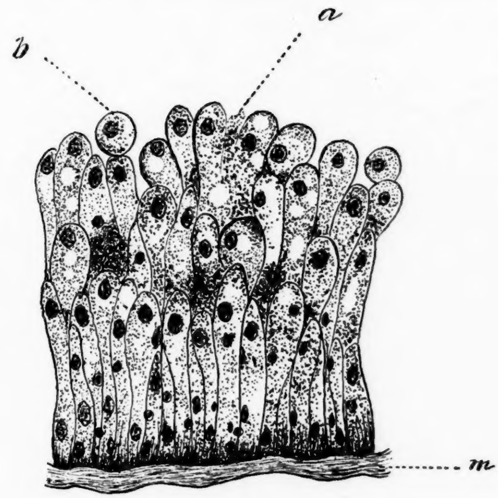

FIG. 6.— Portion of a transection through the basal region of hydranth showing *a*, gland cells sloughing off into hydranth cavity and *b*, others projected bodily into cavity; *m*, mesoglœa.

gland cells possess a distinct nucleus and nucleolus. The protoplasm often presents a finely alveolar structure. Lying in the protoplasm are numerous minute granules and very often granules of a larger size. The whole structure presents a striking similarity to the digestive epithelium of the larvæ of some of the insects. Needham gives a description of the digestive glands of dragon fly nymphs which corresponds in considerable detail with what we find in Corymorpha.

In Hydra and in most of the simpler hydroid polypes, the

digestive cavity consists of a simple tube traversing the long axis of the body, but dilated in the region of the hydranth. The function of digestion is not limited to any particular region of this enteric cavity, but is carried on to a greater or less extent in all its parts. In Corymorpha, however, the enteric cavity

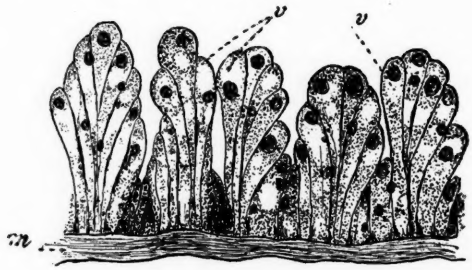

FIG. 7. — Portion of a transection through the distal region of hydranth, showing character of gland cells. *v*, vacuoles; *m*, mesoglœa.

does not remain a single tube, but becomes differentiated into secondary cavities having the character of pouches and canals. From the histological character of these extensions of the primi tive digestive cavity, we see that they are not only morphological differentiations of the latter, but that they also correspond to distinct physiological differences. As stated above, the gland cells are highly developed in the hydranth, but are entirely absent from the cœnosarcal canals; that is, the physiological activity of the digestive cavity is not shared by the canals which arise from it, and the function of digestion has become localized. It would seem to be strongly probable that we have here a specific case of localized digestion and the subsequent distribution of its products by means of the cœnosarcal canals. The central primary space together with the accessory spaces constitutes what might be termed a gastro-vascular system, the cœnosarcal canals undertaking the function of a circulatory system. The gastric system in Corymorpha then may be distinguished from that of Hydra and of the simpler hydroid polypes by this exhibition of a higher differentiation.

(*d*.) *Tentacles*.—The ectoderm of the tentacles consists of short columnar cells with large distinct nuclei. Scattered among

these cells are numerous large thread cells. The entoderm consists of large irregular polygonal cells which entirely fill up the axis of the tentacle. Toward the distal end, the entoderm cells become fewer and larger, their boundaries stretched transversely across the tentacle in longitudinal section, thus giving it a peculiar septate appearance.

The ectoderm and entoderm are separated from each other by a thin supporting lamella, the mesoglœa, which also separates the two layers of cells in other portions of the hydroid.

Origin and Development of the Medusa.

The medusoids in this species are found at the extremities of a number of hollow branched peduncles. These peduncles are from fifteen to twenty-five in number and are arranged in two circles about the hydranth just above the proximal set of tentacles. On the same specimen will usually be found medusoids in various stages of development, from buds just forming, to rather mature Medusæ, together with intermediate stages. The general order of development of the medusa buds is centripetal, that is, the younger buds are usually found at the bases of the branches, while the older ones appear at the distal extremities of the branches.

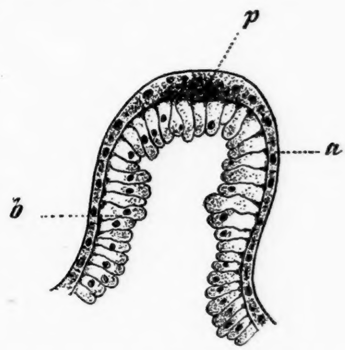

Fig. 8. — An early stage in the development of the medusa bud, showing the formation of germinal cells *p*, from the ectoderm *a*; *b*, entoderm.

The peduncles upon which the Medusæ are borne are simple hollow outpushings of the hydranth and are composed of the same layers — ectoderm, entoderm and mesogœla. In their development the medusa buds present essentially the same succession of phenomena which we find in other Tubulariæ. They begin as simple evaginations of the wall of the penduncle. (Fig. 8.) By a proliferation of the ectoderm

cells in the distal end of the bud, a plug of ectodermal cells is formed which grows down into the medusoid cavity, forcing back the entoderm as it advances. This retreating fold of entoderm, as it doubles upon itself by the increased growth of the ectodermal plug, presses closely upon only four meridional areas of the stationary layer of entoderm. By this process, four equidistant spaces or chymiferous channels are left in direct communication with the medusoid cavity. These spaces constitute the beginnings of the radial canals. (Fig. 9, *c*.) As these channels continue to elongate, they become dilated at their extremities into bulb like expansions which evidently give rise to the circular canals. Early in the process of development, the entoderm, forces its way back through the center of the ectodermal plug to form the manubrium. (Fig. 9, *m*.) The mass of cells lying between the bell and the manubrium, and which are of ectodermal origin, give rise to the future reproductive elements. (Fig. 9, *g*.) The inner ectodermal layer of the bell, and the ectodermal layer of the manubrium arise as successive differentiations of the germinal layer. (Fig. 10, *i. c.*)

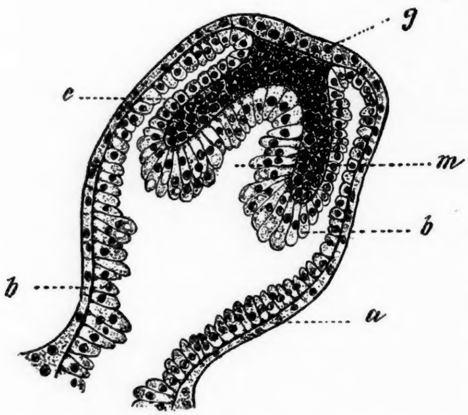

FIG. 9.— A later stage in the development of the medusa bud, showing the mode of formation of the manubrium *m*, and the radial canals *c*; *g*, germinal layer; *b*, entoderm; *a*, ectoderm.

L. Agassiz ('62, p. 278) says, "the medusa buds of this Hydroid do not become free individuals, but remain attached, develop their generative material and then wither and die."

A. Agassiz ('65, p. 193) on the other hand, in speaking of the Medusa of *Corymorpha pendula* says, "Although the separation of this Medusa from its Hydrarium has not been observed,

yet their similarity to the most advanced Medusa buds observed on our Corymorpha, leaves but little doubt on this point." Torrey (:02, p. 38) in his observations on *C. palma* states that the gonophores do not become free. The eggs "drop from the Manumbrium of the attached Medusa" and "there is no free swimming larva." Dr. Hargitt tells me that in his mind there is no doubt that the gonophore sometimes becomes free. On a number of occasions hydroids have been taken by him, which

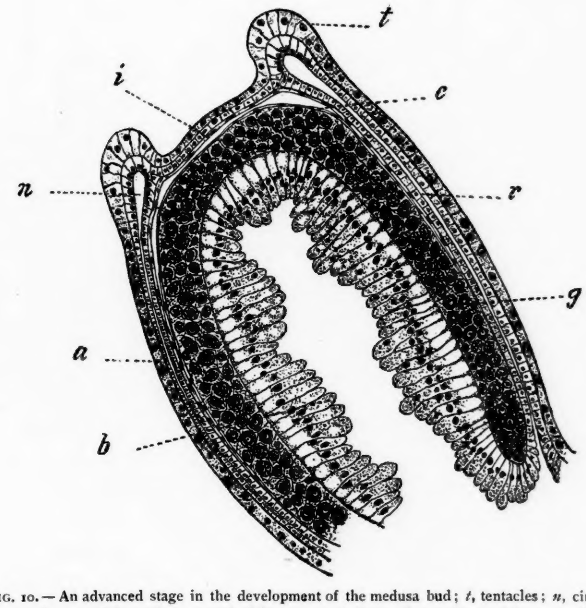

FIG. 10. — An advanced stage in the development of the medusa bud; *t*, tentacles; *n*, circular canal; *r*, radial canal; *g*, germinal layer; *a*, ectoderm; *b*, entoderm; *i*, inner ectodermal layer of bell; *c*, ectodermal layer of manubrium.

bore Medusæ in all stages of development, and at the same time, from waters close about where the hydroids were dredged, free medusæ. These Medusæ unmistakably belonged to Corymorpha and there seems to be but little doubt as to the indentity of their relations. We have here a condition just intermediate between the fixed and the free gonophore phases, a phenomenon not very uncommon among the Tubularidæ.

Oögenesis. — Between the manubrium and the bell is a large mass of cells, which as we have seen above, is derived from the ectoderm and is destined to give rise to the future reproductive elements. Brauer ('91, p. 575) in speaking of the origin of the genital products in *Tubularia mesembryanthemum* says, "Die Geschlechtsprodukte von Tubularia entstehen aus interstitiellen zellen des Ektoderms des Gonophorenträgers, sie treten nahe der Ursprungstätte eines Gonophors ins Entoderm über, wandern hier ihrer Reifungsstätte, dem ektodermalen Glockenkern, zu."

Weismann ('83) states that in some hydroids, the reproductive elements may originate in the cœnosarc of the trophosome. While this is very rarely the case in hydroids where a definite medusoid is developed, I have found one case where there appeared to be a small egg cell in the ectoderm of the stem. The cells of the germinal layer, especially in female gonophores, are a great deal larger than those of the surrounding layers. They are closely packed together, nearly spherical in form, and possess large distinct nuclei with prominent nucleoli. (Fig. 11, *a*.) For a time these cells all increase slightly in size, the protoplasm in the meantime becoming somewhat denser from the periphery toward the center of the cell. At this stage may generally be found four or five cells which are outstripping their neighbors in growth and are attaining a considerably greater size. These cells are destined to develop into mature ova and are found for the most part occupying a position next to the manubrium. They now assume a distinct amœboid form sending out a

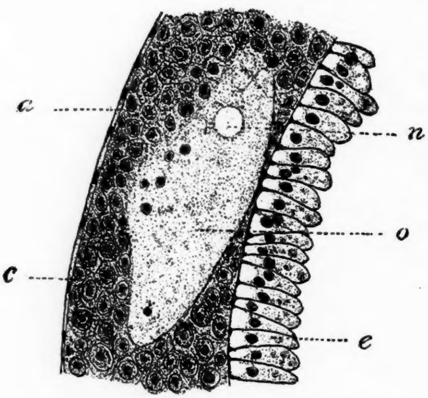

FIG. 11. — Portion of a transection through a late medusa bud showing the growth of the ovum by absorption of primitive egg cells; *o*, ovum; *n*, nucleus of ovum; *e*, entoderm; *a*, ectodermal layer of manubrium.

number of pseudopodia-like processes among the adjacent cells and finally absorbing them into their own substance. (Figs. 11, 12.) The phenomenon as I have observed it is essentially as described by Doflein ('96) for *Tubularia larynx*.

The boundaries between one of the large cells and those adjacent to it begin to break down. This large cell which, according to Doflein has had the advantage of position and nourishment, at once appropriates to itself the protoplasm of these surrounding cells. A syncytium with irregular outline is thus formed from the fusion of these cells, and in it may be detected for some time the disintegrating nuclei of the absorbed cells. (Fig. 12, *b*.)

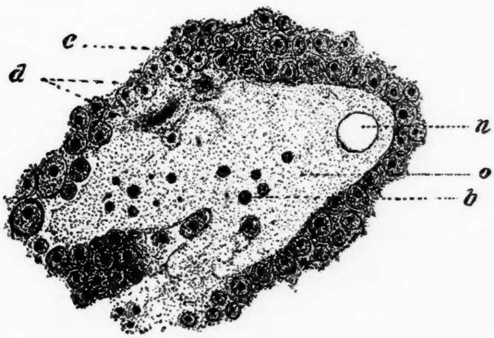

FIG. 12. — Absorption of primitive egg cells by growing ovum; *b*, nucleus of absorbed cell in state of disintegration; *d*, entire cells lying within the ovum; *c*, primitive egg cells; *n*, nucleus.

In regard to the process of absorption, there are two distinct views. In Doflein's words ('96, *p.* 1):—

"Die einen Forscher nehmen an dass die Eizelle die umgebenden Nährzellen aktiv auffrisst, sich von denselben, wie eine Amöbe von anderen Organismen ernährt. Dagegen behaupten Andere eine Auflösung der Nährzellen und eine Aufnahme derselben in flüssigem Zustand."

Doflein ('96) contends that the process of absorption described by Balfour and Tichomiroff as "*amœboides Fressen*" is decidedly incorrect and that the protoplasmic processes of the developing ova do not function as true mouths which bodily engulf the adjacent primitive ova. While my results in general con-

firm this view of Doflein's, nevertheless in one or two cases there seemed to be a distinct engulfment of the primitive ova. It appears to me that neither theory alone explains all the phenomena involved in the growth of the ovum, but that a combination of both theories would better explain the facts. My observations, however, lead me to agree with Doflein in his objection to the term "amoeboides Fressen." If we watch an Amœba in its movements, we will observe that when a process of the protoplasm presses against certain foreign particles of organic nature, they become sunk in the substance and pass gradually into the interior. Here they become surrounded by a little globule of watery fluid, a vacuole; and by degrees these particles partially or wholly disappear. All the matter which is capable of it becomes digested and assimilated by the protoplasm. It is very probable that the vacuole contains some ingredient of the nature of a ferment which is capable of acting upon these foreign substances and rendering them more soluble. These are the phenomena involved in the process of amœboid eating. Yet, while they agree in a few respects with those phenomena which are exhibited in the growth of the ovum, on the other hand, it seems to me that they present such fundamental differences as not entirely to warrant the statements of Balfour and Tichomiroff. In the first place, there is no formation of a vacuole about the absorbed cells, with the exception of, later on, a small one about their nuclei. I did not find these vacuoles in any sections of Corymorpha, but in examining some slides prepared by Miss Allen (:00) in her study of the development of *Tubularia crocea*, I found numerous cases of these vacuoles containing, from one to as many as seven or eight nuclei. These vacuoles however, were all found in ova which had begun to segment, and undoubtedly the same phenomenon would have presented itself in Corymorpha, if the material used had been of a later stage of development. Doflein ('96) describes the same thing in *Tubularia larynx*.

Furthermore, the cytoplasm of the absorbed cells simply mingles with that of the growing ovum, and undergoes no apparent change whatsoever. There is no process of absorption, the cell walls disappear gradually and the nuclei appear to have been

carried along in all directions by a "streaming motion of the plasma of the ovum." While I could not observe such a process in the preserved material, the "general agreement of authors on this point" (as Doflein states) makes it quite certain that this phenomenon of amœboid movement does exist.

Miss Allen (:00) in her observation on *Tubularia crocea*, says that in numerous cases the outlines of the absorbed eggs could be distinguished in the protoplasm of the absorbing egg. In a very few favorable sections, I have been able to detect the outlines of these absorbed cells (Fig. 12, *d.*), but in most cases only the nuclei were distinguishable.

A great many of the primitive ova do not thus become absorbed, but remain scattered among the mature eggs in their original undeveloped state. Doflein suggests that possibly, after the larvæ have left the gonophore, these remaining germ tissue cells unite to form new eggs.

Summary.

In summarizing the results obtained in this study, the following points should be noted :

1. Corymorpha, in keeping with its usual description, is a solitary form.

2. The rhizoidal filaments of attachment are formed as secretions from the papilliform processes.

Both filaments and papillæ are modifications of the same structure.

3. The central axis of the stem is filled with a mass of parenchyma-like cells in which is excavated a number of longitudinal canals. The longitudinal canals are extensions of the hydranth cavity.

4. Gland cells are highly developed in the hydranth cavity, but are entirely absent from the cœnosarcal canals. The function of digestion thus becomes localized in one portion of the enteric cavity while the cœnosarcal canals function as a circulatory system. A fairly well differentiated gastro-vascular system thus becomes developed.

5. The medusoid is developed from a bud which is formed by a simple outgrowth of the wall of the peduncle.

6. The chymiferous canals of the medusoid are formed by a fusion of the two layers of entoderm throughout the inter-radial areas.

7. The sex cells are derived from a plug of ectodermal cells formed at the apex of the bud.

8. The eggs develop by a process of absorption of the cells of the germinal tissue, thus giving rise to an amœboid syncytium.

9. The nuclei of the primitive germ cells persist for some time in this syncytium, but gradually disintegrate.

THE ZOÖLOGICAL LABORATORY,
SYRACUSE UNIVERSITY,
April 25, 1903.

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THE HABITS OF CAMBARUS.

J. ARTHUR HARRIS.

It is the purpose of the present paper [1] to present in a brief way some of the main points which have been collected on the habits and distribution of North American crayfishes.

Our crayfishes offer a particularly inviting and important field for ecological work. A fuller knowledge of the habits of the different species may contribute to a more complete understanding of the very remarkable sexual dimorphism occurring in the adult males. Individual variability in the species of Cambarus is very great and puzzling, and the differentiation into species as compared with the other genus Astacus, of the subfamily to which it belongs is extensive. The great differences in environment to which the species are subjected is apparent to anyone who is acquainted with the physiographic conditions prevailing in the vast stretch of territory over which this genus is distributed and an examination of these conditions and the adaptation of the animals to them would doubtless yield interesting results.

The habits of any species necessarily depend largely upon the character of its environment, and from an ecological or biological standpoint it is impossible to consider the two separately. In this place space cannot be given to a discussion of the importance of a correlation of physiographic features with floral and faunal distribution as it has been emphasized by Woodworth, Hays and Campbell, Simpson, Cowles, Adams and others.

It has long been known that the fishes occurring in the upper course of a stream of considerable size are different from those found in its lower course, and more recently the ecological factors concerned have been more fully discussed. In the crayfishes as in fishes the Fauna of different parts of a stream is not the same,

[1] This is an abstract of a part of an ecological catalogue of the crayfishes belonging to the genus Cambarus which is being published in the *Kansas University Science Bulletin.*

but in the crayfishes the problem is not a simple one since the animals may remain out of water for a considerable length of time and it is to be expected that the conditions under which they may be found are not always the same. *C. virilis* usually occurs in running streams but may also be found in stagnant ponds with *C. immunis* and *C. gracilis* and has been known to resort to burrowing. *C. bartonii* seems to be characteristic of the cooler mountain springs and streams, but it is also found in limestone caves with *C. pellucidus* and associated with *C. diogenes*, a burrowing species, with the same habits. *C. affinis* and *C. blandingii* may also be used as illustrations of the same point.

While an examination of a table of distribution of species offers some interesting suggestions, it is as yet impossible to prepare a list of species characteristic of certain types of localities, though many species may be accurately assigned.

Several species appear to be confined to mountain streams. The crayfishes of the Ozark Mountains are little known, but the point is illustrated in the Appalachian tributaries of streams emptying into the Atlantic Ocean and the Gulf of Mexico. The lower courses of these streams are very different from their sources and the general Fauna is very different. *C. extraneus*, *C. spinosus*, *C. bartonii*, *C. acuminatus*, *C. forceps*, *C. longulus* and other species seem to be confined for the most part to mountain streams. As is the case in fishes, the same species may occur in the head waters of streams originating on opposite sides of a divide and debouching at widely separated points. Some species found in the lowland portions of the same streams are characteristic so far as yet known, and some idea of the species characteristic of the lower portions of the course of a stream — the lowland forms — may be gained from an examination of a list of the forms reported from the Atlantic coast plain and the lower portions of the Gulf States. It must be remembered, however, that elevation above the sea is not the only factor producing lowland conditions so far as faunal and floral distribution is concerned.

Faxon pointed out that the greater the fall of a stream the greater the difference between the species of the upper and lower portion of its course and while the question needs careful

investigation the same seems to be true of the number of species found in a given stream ; a river with a heavy fall having a larger number of species than one with the same or greater length, but having a more limited vertical range. It is apparent that the former would present much more diverse life conditions than the latter.

The habits of certain of the North American species of crayfishes have attracted considerable attention. These are the burrowing species. As burrowing species are to be designated only those forms which show an especial dependence upon this method of life, since it is reasonable to suppose that most, if not all the stream-inhabiting species dig short burrows in the banks at least in certain localities. The species which seem to be most dependent on this habit are *C. diogenes*, *C. gracilis*, *C. carolinus*, *C. argillicola*, *C. simulans* and *C. immunis*.

C. diogenes has well been characterized as preëminently a burrowing species. Its presence is usually indicated in the low places where it is most frequently found by the large number of mud "chimneys," about a foot in height, sometimes scattered over several acres, radiating from some sluggish stream, ditch, brook or lower, moister portion of the area, the animals being frequently found at a considerable distance from any permanent body of water. Of the other species *C. gracilis* seems to be as typically a burrowing species as *C. diogenes*, and is generally reported as an inhabitant of prairie regions. Adults are to be found in open ponds only in the early spring, and the burrows are often found at long distance from any permanent body of water. *C. simulans* has been reported from streams and ponds and from burrows in a slough. *C. immunis* is known principally from stagnant ponds, resorting to burrowing upon the drying up of the ponds and upon the approach of winter. Of *C. argillicola* and *C. carolinus* the nature of the habitat has not been described.

All of the above are known to be "chimney-building" species. The "chimney," very aptly so called, is a mound of mud of a quite regular, conical or pyramidal form constructed at the mouth of the burrow, with a smooth, internal opening which is merely a continuation of the shaft of the burrow, and is sometimes sealed at the top. The chimneys of all the species have

not been carefully described, but so far as known they are essentially the same. That of *C. diogenes* has a maximum height of twelve inches, but is usually lower, is in shape, like a truncated cone often somewhat higher than broad. The most remarkable difference being that of chimneys two inches in diameter and eight to eleven inches in height, described by Abbott, who states that those found in meadows at a distance from running water were invariably broader and not so high as those erected near running water. The chimney is composed of pellets of clay firmly cemented together, owing to the moist condition in which they are laid on, giving an irregular, nodular appearance to the outside of the structure. This brief description applies to the more perfectly formed or typical chimney. We will recur to this subject later, after the form of the burrow has been mentioned. The actual process of construction has been observed only once.

As has been suggested above, where the habits of the different forms was mentioned, the burrows are made at the time of the drying up or the lowering of the body of water in which the animals are found. At the edge the burrow may be a simple shaft, a foot, more or less, in depth, ending below in a cistern-shaped enlargement, in which the animal, usually only one but sometimes two, is found. Farther back from the stream in moist meadows where the burrows may have been begun at the time of high water, the depth must necessarily be much greater to reach soil water during the prolonged heat of summer. These burrows are not uniform in structure but as yet data are lacking for the determination of any plan, other than the one of reaching water in the most direct manner. The presence of more than one opening to the same burrow has often been noticed. They are usually quite simple but occasionally are branched in various ways. When many burrows occur in a limited area they may easily become connected accidentally. Enlargements in the shaft of the burrow have been noticed and attributed to the original enlargement at the bottom of the burrow which has been repeatedly carried deeper as the water in the soil became lower. In recent observations on *C. carolinus* this explanation does not seem to hold.

Too much importance, it seems to me, has been attributed to the chimney in discussions of the habits of Cambarus. While the chimney is usually a very regular and well-built structure, it is often found, in some species at least, as a more or less irregular heap of clay pellets, and so far as our present knowledge extends, can hardly be regarded as anything more than the result of the easiest method of disposing of the material removed in excavating the burrow. On this point, however, further observations are desirable. The purpose of the sealing of the burrow is not so clear. The prevention of material falling into the burrow from the surface and possibly (?) protection against enemies may account for it. That the sealing is not a matter of the accidental falling together of the upper edges of the chimney while in a moist condition is evident from the fact that the opening is sometimes filled to below the surface of the ground and, as sometimes happens, with clay of a different nature from that composing the rest of the chimney.

Concerning the purpose of burrowing there can now be no question. Some species of Cambarus seem never to resort to the habit, in the restricted interpretation of the term, while others, *C. immunis*, and, to a less extent, *C. virilis*, are inhabitants of ponds or streams and resort to burrowing only upon the drying up of the ponds or the approach of winter, while *C. diogenes* and *C. gracilis* have adopted this mode of life almost entirely, being found in the open water during but a very small part of the year. That the burrows are not for retreats while the eggs are being hatched has been conclusively shown. That they serve as a place of protection against enemies has been suggested and while it cannot be stated that the burrowing species are not better protected against animal enemies than are the forms inhabiting open water this cannot be the primary purpose of the burrow. The burrows are almost invariably described as extending to the water in the soil, and while the water in the enlargement at the bottom of the burrow is usually very muddy, it enables the animal to keep its gills moist. A point of interest in connection with the burrowing species is the range of the species. *C. diogenes* seems to be the most widely distributed species. *C. argillicola* has a wide distribution, and *C. carolinus*

has been reported from widely separated localities. To what extent this is dependent on the habits of the animals is difficult to say, but the burrowing species obviously have a great advantage over the others in their ability to occupy territory which would be habitable to many of the species for but a very small portion of the year.

Only one species is found in salt water, *C. uhleri*, a species of limited range, is found in salt marshes covered twice daily by the tide, and also in brackish and fresh water where *C. blandingii* is sometimes found associated with it. *C. montezumæ* is said to occur in salt water.

Many observations have been made upon the blind species, inhabiting caves and underground streams in Kentucky, Tennessee, Indiana, Missouri and Florida, but they are not of a nature to be easily summarized. The blind forms are not confined to one group or section of the genus. The species are: *C. acherontis*, *C. setosus*, *C. hamulatus*, *C. pellucidus* and *C. pellucidus testii*.

Parasites, various species of Branchiobdella, have been noticed on *C. affinis*, *C. bartonii*, *C. digueti* and *Cambarus* sp. and will doubtless be found on many other forms, and *C. digueti* is recorded as being attacked by Temnocephala.

Little has been recorded of the habits of the crayfishes during the winter. It seems most probable that the stream inhabiting species pass the winter in burrows in the bank or under stones, etc., in the bed of the stream. The latter is sometimes the case with *C. virilis*. The burrowing species seem quite generally to spend the winter in the burrows, coming out early in the spring and returning again when the water begins to become low as the summer progresses.

Observations have been made on the colors of the crayfish in relation to its environment. One observer, working, for the most part, on *C. immunis*, with fewer observations on *C. propinquus*, *C. bartonii* and *C. diogenes*, concludes that the coloring closely resembles the environment and has a protective function. According to him, the colors in all cases were similar to the environment except in those with a red coloration. The red color, he concludes, is due to the immediate effect of the sunlight.

He found that young crayfishes which are red, due to the presence of large chromatophores, changed to blue or black or suffered no change as the adults of the locality were blue, black or red. He finds that the burrowing crayfish, *C. diogenes*, comes out in the spring much the color of the soil, but this color is gradually changed to red in the open sunlight. Other observations indicate that in the case of *C. gracilis*, as typically a burrowing species as *C. diogenes*, the females are always olive-green no change taking place during the time they are to be found in the ponds in the spring, while the few males which have been taken are a marked salmon red, although they had just left the burrow. In *C. carolinus*, another burrowing species, "red" and "blue" individuals seem to occur. While it is undoubtedly true that individuals of a species taken from different localities may show marked differences in coloration, caution must be exercised in designating all the differences as protective adaptations.

Observations on the breeding habits are very limited. As to the time of copulation and oviposition a few data have been recorded. In *C. diogenes*, upon the habits of which more has been written than any other species, copulation and oviposition seem to occur in the spring. One observer found females in burrows carrying eggs in March and April, while another gives the middle of May as the approximate time of hatching of the eggs. Another observed *C. diogenes* and *C. gracilis*, kept in aquaria, copulating in the spring and never found crayfishes (sp ?) mating except in March, April and sometimes May, and was able to get reports of females "in berry" later than June in only two instances. Another observer reports the species as copulating in the open water April 2nd and laying eggs April 18th to 30th. A female with eggs in an early stage of development has been reported May 3rd. These observations were made over a wide range of territory. An interesting exception is the taking of a female with eggs nearly ready to hatch, on January 1st and might suggest autumn oviposition, as has been observed in some other species. Females of *C. gracilis* have sometimes been found in open ponds in early spring with a *few* young and it may be that the young leave the parent immedi-

ately after they quit the burrows in the spring. In southern Kansas, *C. simulans* has been taken from burrows, with eggs apparently recently laid, late in August, and in New Mexico, with the swimmerets loaded with eggs, in May. In *C. immunis* the females are found with eggs in stagnant ponds in the fall; they pass the winter in burrows and appear again in ponds, where the process of hatching is completed, in the early spring — about March 21st. *C. argillicola* has been reported with young as early as April 2nd. *C. neglectus* was found with eggs and young in the cold water at the mouth of a large limestone cave in the Ozarks early in June, and since those taken at the same time in various other places in the neighborhood had neither eggs nor young, the lateness of the date may be attributed to the retarding effect of the low temperature upon the hatching of the eggs. In another locality *C. neglectus* (?) was taken with eggs April 13th. In *C. virilis* the females are found with eggs in the spring, but not during the winter.

Of the above species *C. diogenes* and *C. gracilis* are preëminently burrowing forms, *C. argillicola* is a burrower, *C. simulans* burrows extensively as does also *C. immunis*, and *C. virilis* sometimes resorts to the habit. *C. neglectus* seems to be found principally, in clear rocky streams. In regard to the burrowing species it has been suggested that the burrow is designed as a retreat while the eggs are being hatched, but this is not very likely, although the eggs may undergo a very large part of their development in the burrow.

Observations on the habits of the young crayfish are few. Two suggestive ones are that in *C. diogenes* the neatest chimneys are those constructed by the smallest individuals and that the young of *C. gracilis* are the first to appear in the stagnant ponds which are frequented by this species in early spring and are also found there in the late summer after other forms, *C. immunis*, *C. virilis*, and the adults of *C. gracilis*, have gone into their burrows.

St. Louis, Mo., Mar. 22, 1903.

SYNOPSES OF NORTH AMERICAN INVERTEBRATES.

XIX. The Trichodectidæ.[1]

MAX MORSE.

The genus Trichodectes, the only genus of the family Trichodectidæ, is one of the two genera of the order Mallophaga which are found on mammals. From the other genus, Gyropus, Trichodectes is distinguished by the fact that its members have a three-jointed antenna. The order Mallophaga has been divided by Piaget ('80) into two families, *viz.*, the family Liotheidæ and the family Philopteridæ — the two being distinguished by the character of the legs which are modified either for running (the former) or for clasping (the latter). Kellogg ('99) has separated the genus Trichodectes from the Philopteridæ by the erection of the family Trichodectidæ which he attributes to Burmeister. His authority for this attribution is not evident. Of the 48 species in the genus, 18 are considered here as having been taken on North American Mammals.

The species of Trichodectes are distinguished from one another by such characters as the size and shape of the antennæ, the character of the setæ, or hairs that clothe the body, the shape of the thorax, the genitalia of both male and female, etc. In the present paper, at the suggestion of Prof. Herbert Osborn, much attention has been paid to the so-called "abdominal appendages" of Piaget. This organ, for it is all one organ, is a growth of the posterior ventral edge of the antepenultimate segment of the abdomen, in the female. The extension grows backward, underlying the major portion of the last abdominal segment and growing upward at the sides to reach the level of the tergum of that segment. The median portion of the extension, however, does not grow very far backward and the result is the formation of

[1] Contributions from the Department of Zoölogy and Entomology of the Ohio State University, Number 12.

two lateral flaps as can be seen in the figures. Dorsally it has the appearance of forming a prominent curved hook at either side. Much variation in this organ in the several species was found and its general shape, together with the presence or absence of setæ on it afford excellent criteria for the separation of species. The function of the abdominal appendage is partly in clinging to the hairs of the host but more especially in the adjustment of the eggs to the hairs.

A word may be said concerning the general habits of these insects. Their food consists of scales and epidermal excretions from the host. The mouth-parts are fitted for biting and the mandibles are well developed. They cling to the hairs of the host by means of the mandibles, which are set at the posterior end of a clypeal groove running longitudinally along the ventral side of the head, into which groove may be fitted a hair and this then grasped by the mandibles. It is probable that the sides of the groove are capable of being closed down over the hair and thus anchor the Mallophagan to the host, without the assistance of the mandibles. The legs, also, assist in holding the insect to the hair. The office of the abdominal appendage has been mentioned. The eggs are often seen in the body of the specimen. There is a well-developed lid fitting over a chitinous capsule. The capsule is glued to a hair and development occurs there, the lid being shoved off at the emergence of the larva. Most of the species are confined to one species of host, although exceptions are met with.

Only those species known to occur in North America are considered here. It is hoped that by the aid of the keys, the figures and the descriptions, any member of the group in the region defined may be identified, even if the host is not known. The characters in the key are given in the main for either sex and none of these characters are difficult of examination. A ready method of preparation is to boil a few minutes in a solution of potassic hydrate in water, clear in carbolic acid and mount in balsam.

No claim to completeness is made for this paper, for it is improbable that it includes all the species to be found on North American mammals. Doubtless there are species imported from Europe that have thus far escaped our notice.

Acknowledgments are due Professor Vernon L. Kellogg, Professor Lawrence Bruner, Dr. L. O. Howard, and Dr. D. E. Salmon, for material. My thanks are especially due Professor Herbert Osborn of the Ohio State University, under whom the work was done and who has offered valuable suggestions in the course of the work. The private collection of Professor Osborn, which embraces nearly all the species considered in this paper was put at the disposal of the writer.

The literature of the group is not large, but I append only the more important papers from the point of view of the worker in North America.

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For further treatment the reader is referred to the works of Osborn and Kellogg as well as those of Piaget that have been cited above.

KEY.

a. Setæ short and delicate, not reaching middle of the succeeding segment. Female abdominal appendage with setæ . . (RUMINANT TYPE.)

b. Head convex in front.

c. Head pointed, spines on the anterior border of the female abdominal appendage small and inconspicuous . . . . *scalaris.*

cc. Head rounded, spines on anterior border of the female abdominal appendage equalling in size those on the posterior.

d. Form elongated, setæ of antennæ strong and conspicuous.

e. First tarsal joint of third leg extended; portion of head anterior to antennæ wider than posterior; inner border of female abdominal appendages lobed. *sphærocephalus.*

ee. Not as above, inner border of female abdominal appendage straight . . . . *parumpilosus.*

dd. Form short and thick, antennal setæ delicate and inconspicuous.

f. Abdomen wider than head, thoracic suture evident, ventral border of penultimate segment of the abdomen with deep emargination in the median line. *limbatus.*

ff. Abdomen width of or less than head, thoracic suture not evident, border very slightly emarginate. *climax.*

bb. Head emarginate in front.

g. Distal portion of inner border of tibia of third legs translucent, with setæ short and delicate.

h. Prothoracic spiracle situated internally, not on lateral edge of the prothorax . . . . *tibialis.*

hh. Prothoracic spiracle extending laterally beyond edge of segment . . . . *parallelus.*

gg. Same chitinized and fringed with heavy long setæ . *setosus.*

aa. Setæ long, linear, reaching or extending beyond the middle of the next posterior segment; female abdominal appendage without setæ. (CARNIVORE AND RODENT TYPE.)

i. Head pointed . . . . *subrostratus.*

ii. Head not pointed.

j. Antennæ with proximal joint in the male swollen and having the whole antenna long.

k. Second antennal joint in the female with posterior process. *geomydis.*

kk. Second antennal joint in female without process.

l. Prothorax long, twice the length of the meso-metathorax.

m. Anterior border of the head converging to a point. *californicus.*

mm. Anterior border of the head convex-rounding. *castoris.*

ll. Prothorax short, equalling in length the posterior part.

n. Length under one mm. . . . . . . *mephitidis.*

nn. Length over one mm. . . . . . . *thoracicus.*

jj. Antennæ linear, the proximal joint not swollen.

o. A series of long, strong spines on the posterior border of the metathorax. . . . . *nasuatis.*

oo. Spines limited to the lateral portions of the posterior border of the metathorax.

p. Præocular sinus in the male wide, the præantennal spur being widely separated from the eye.

q. Length over 1.50 mm. . . . . *latus.*

qq. Length under 1.50 mm. . . . . *retusus.*

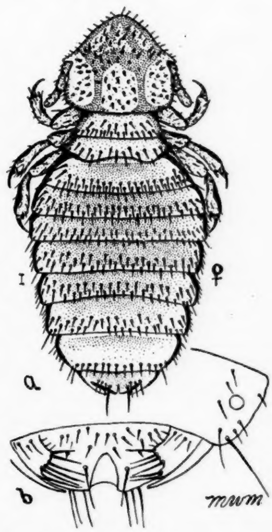
pp. Sinus narrow, the eye being close to the præantennal spur . . . . *quadraticeps.*

Descriptions.

Family **Trichodectidæ.** Kellogg.

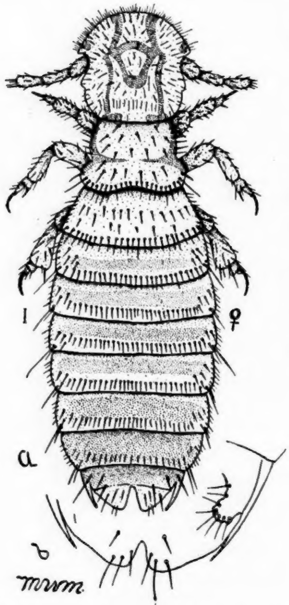
Genus Trichodectes. Nitzsch.

T. scalaris Nitzsch. Female: Length, 1.368 mm.; width of abdomen, .666 mm.; head, .342 mm.; thorax, .180 mm.; antennæ, .154 mm. Outline of body elliptical. Head not as broad as abdomen, roughly triangular in outline, front converging to a bluntly-pointed anterior margin. Antennæ linear and small. Thorax trapezoidal. Pro-mesothoracic suture distinct. Mesometathorax with lateral borders salient and prominent, with strong setæ; posterior border of thorax sinuous. Abdomen widest on segment 3. Lateral borders of segments dark, heavily covered with setæ. Segments 1–8 with transverse, fuscous bands. Setæ strong, but short and blunt. Head covered with setæ as is also the case with the abdomen. No male specimen available. On domestic cattle.



T. scalaris, a, female; *b,* abdominal appendage of female.

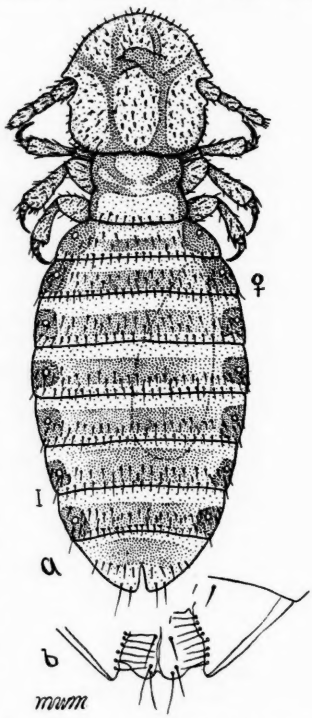
T. sphærocephalus Nitzsch. Female: Length, 1.764 mm.; width, .63.; head, .396; thorax, .27; Antenna, 27. Body elongated, narrow. Head not as broad as abdomen, squarish, semicircular in outline in front of the antennæ. Prothorax not well marked off from rest of thorax and narrower than meso-metathorax. Posterior border of metathorax concave. Abdomen elliptical, widest on segments 3 and 4. Middle of segments with smoky brown bands running transversely. First tarsal joints of second and third legs with inner border extended and swollen and surrounded with setæ. Setæ in general, abundant. Antennæ and front of head thickly covered with



T. sphærocephalus. *a*, adult female; *b*, abdominal appendage of female.

setæ. Basal joint of antenna larger than other two joints, distal segment clavate. Tarsal claws long and strong. Male not in hand. On domestic sheep.

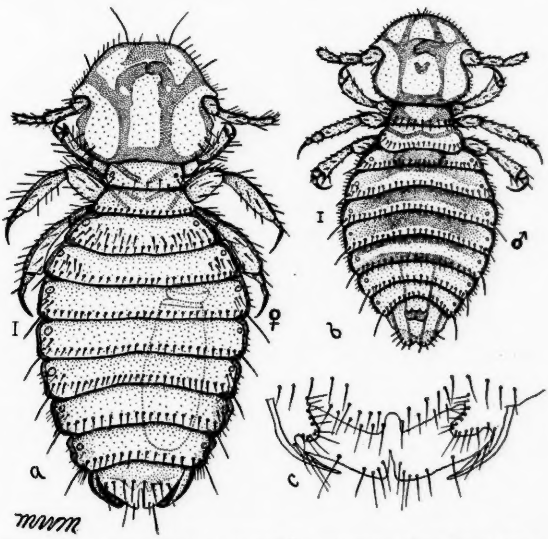
T. parumpilosus Piaget. Length, 2.127 mm.; width, .81; head, .504; thorax, .306; antenna, .27. Form large. Head convex in front, slightly longer than wide, about two thirds as wide as the abdomen. Antennæ stout, linear, proximal joint but little larger than others. Mandibles small. Thorax with the suture indistinct, the two segments being of about equal width. Posterior border convex. Lateral borders of the two portions of the thorax parallel. Abdomen with stigmata surrounded by dark blotches.



T. parumpilosus. *a*, adult female; *b*, abdominal appendage of female.

Interior of segments transversely banded. Setæ delicate, short and inconspicuous. Tarsal claws slender. Male not in hand. Found on the horse. This is a synonym of *equi* Denny.

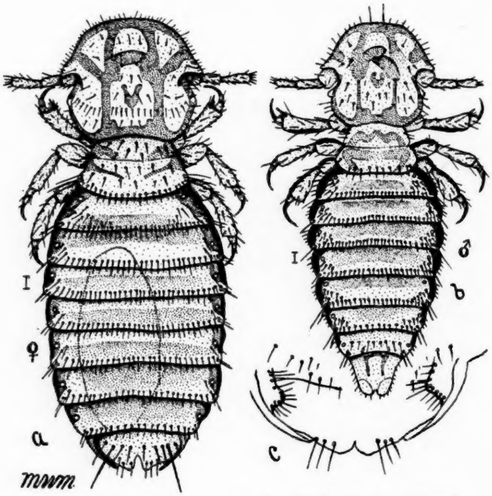
T. limbatus Gervais. Female: Length, 1.71 mm.; width, .828; head, .45; thorax, .22; antenna, 27. Body large, elliptical in outline. Head square, with anterior portion trapezoidal, the anterior border being truncate. Preantennal spur well-developed. Eyes prominent. Antennæ linear. Thorax short, narrow, with antero-lateral angles produced. Abdomen widest on segments 3 and 4, the outline ovate. Lateral borders of the segments dark and heavily chitinized. Tarsus normal, claws strong, slightly



T. limbatus. *a*, adult female; *b*, adult male; *c*, abdominal appendage of female.

curved. Setæ scant and delicate. Male; Length, 1.206 mm.; width, .54; head, .324; thorax, 198; antenna, .234. Smaller than the female, but general shape the same, except that the abdomen converges more abruptly posteriorly from the 3 and 4 segments. Setæ as in the female. From the Common Goat and the Angora Goat.

T. climax Nitzsch. Female: Length, 1.693 mm.; width, .702; head, .45; thorax, .198; antenna, .27. Outline of the body elongated-elliptical. Head square, about three fourths as wide as abdomen. Anterior border only slightly convex, the portion in front of the antennæ being in outline a semicircle. Antennal pit deep, the angle well defined. Antennæ linear, distal segment slightly swollen in the middle. Thorax trapezoidal, the suture not



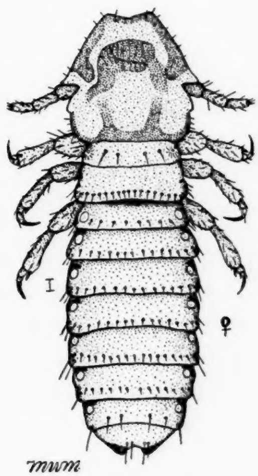
T. climax. *a*, female; *b*, male; *c*, abdominal appendage of female.

T. tibialis. *a*, female; *b*, male.

very distinct. Posterior border convex. Abdomen widest on segments 3 and 4. Lateral borders of the segments dark. Middle of the segments transversely banded. Setæ delicate but profuse. Tarsal claws long and strong. Male: Length, 1.35 mm.; width, .702; head, .378; thorax, .18; antennæ, .27. Head as in the female. Thorax longer in proportion than in the female, but similar in outline. Posterior border slightly concave. Abdomen widest on segments 2 and 3, whence the body outline curves rapidly to the end of the abdomen. Lateral borders of the segments dark and middle of the segments banded transversely. Tarsal claws longer and less curved than in the female. On the Domestic Goat.

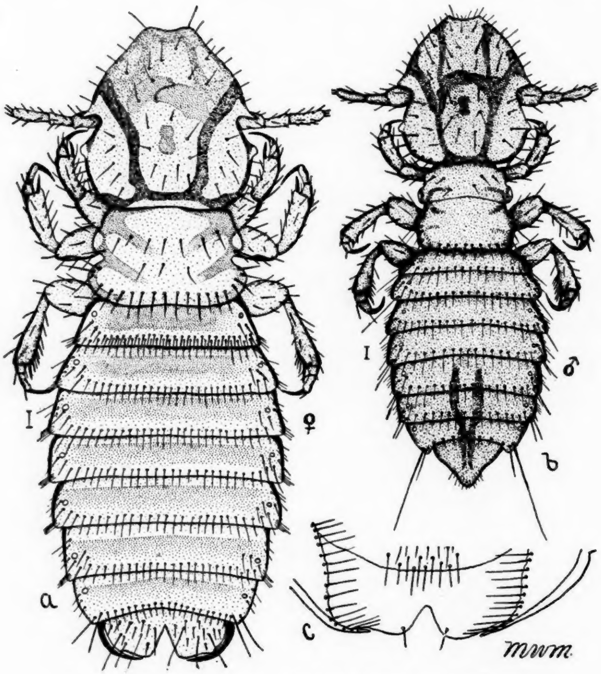
T. tibialis Piaget. Female: Length, 2.016 mm.; width, .756; head, .595; thorax, .288; antenna, 360. Head about as wide as the abdomen, elongated, eyes prominent, preantennal spur obtuse. Mandibles long and strong. Antennæ with distal joint swollen. Thorax narrower than head, margin continuous with the contour of the abdomen. Prothoracic spiracle distinct. Suture fairly evident. Posterior border convex. Abdomen elliptical, with dark blotches in front of the spiracles. Segments with transverse bands. Setæ short and thick, in single transverse rows on the abdomen. Tarsal claws moderately strong. Male; Length, 1.89 mm.; width, .702; head, .612; thorax, .270; antenna, .450. Head as wide as the abdomen. Shape as in the female. Proximal segment of the antenna enlarged. Length of the antenna in the male greater than in the female. Trabeculæ in the head conspicuous. Thorax as in the female, but the lateral angle more extended. Abdomen elongate, with segments transversely banded. Spiracles with blotches as in the female. On the Black-tailed Deer.

Trichodectes parallelus Osborn. Female: Length, 1.56 mm.; width, .45; head, .45; thorax, .21; antenna, .28. Body elongated, abdomen narrow Leipurus-like, the ratio of the length to the width being about 3.1. Widths of the head and abdomen nearly equal. Head with sides in front of the antennæ converging forward. Anterior border of head emarginate. Head heavily chitinized. Joints of antennæ of equal diameter, linear. Thorax square, the suture not distinct. Prothoracic spiracles prominent. Abdomen with sides parallel, beginning to converge towards posterior end at the penultimate segment. Setæ short and delicate, sparse and thinly distributed. Spiracles of the abdomen capped anteriorly with black blotches. Tarsal claws long. Male not known. On a species of deer, the species not being known to the describer.



T. parallelus. Female.

Trichodectes setosus Giebel. Female: Length, 2.304 mm.; width, .846; head, .594; thorax, .396; antenna, .324. Large, elongated. Width of the head and that of the abdomen nearly equal, the latter slightly the greater. Head large, sides in front of the antennæ converging to the slightly concave front border. Antennæ filiform. Thorax large, prothoracic spiracle very prominent. Suture evident. Posterior border slightly concave. Abdomen with the lateral border of the segments chitinized and dark. Middle of the

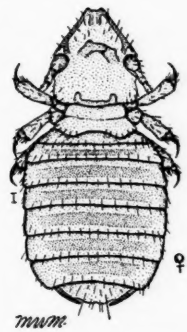


T. setosus. *a*, female; *b*, male; *c*, abdominal appendage of the female.

segments pigmented. Abdomen widest on segments 4 and 5. Setæ short and delicate, well distributed. Tarsal claws long and strong. Male: Length, 1.692; width, .576; head, .486; thorax, .27; antenna, .27. Head more elongated than in the female. General characters as in the female, save that the abdomen is shorter, narrower, widest on segments 3 and 4. Thorax longer, posterior border convex. Proximal joint of the antennæ large. Abdomen terminated in a point. Pro-mesothoracic suture more distinct than in female. On the porcupine, *Erethizon ermineus*, Neb.

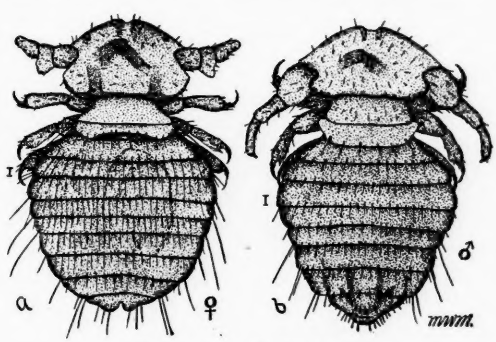
Trichodectes subrostratus Nitzsch. Female: Length, 1.116 mm.; width,

.54; head, .36; thorax, .09; antenna, .114. Head acutely pointed anteriorly. Antenna slender. Thorax short. Suture between prothorax and mesothorax distinct. Posterior border of thorax concave. Abdomen elliptical, obtuse and broad, broadly rounded posteriorly. Segments banded transversely. Setæ inconspicuous. Male not in collection. On the domestic cat.



T. subrostratus. Female.

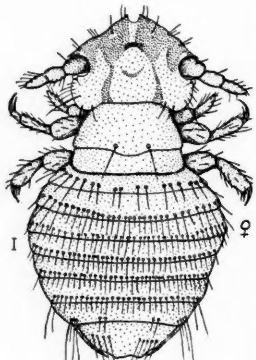
Trichodectes geomydis Osborn. Female: Length, 1.134; width, .66; head, .306; thorax, .162; antenna, .234. Head broader than long. Antennæ thick and short, heavily chitinized, with second joint provided with a posterior extension. Prothorax narrower than meso-metathorax, the latter with lateral borders extended. Posterior border of the thorax concave. Abdomen broad, widest on segments 3 and 4, whence the sides of the abdomen converge gently posteriorly. Setæ delicate and long. Male: Length, 1.08 mm.; width, .63; head, .23; thorax, .114; antenna, .396. Similar to female, but the sides of the abdomen converging posteriorly more abruptly than in the female. Antennæ longer and proximal joint swollen. On the Rodent, *Geomys bursarius*, (Ames, Ia.) and *Thomomys bottæ* (California).



T. geomydis. *a*, female; *b*, male.

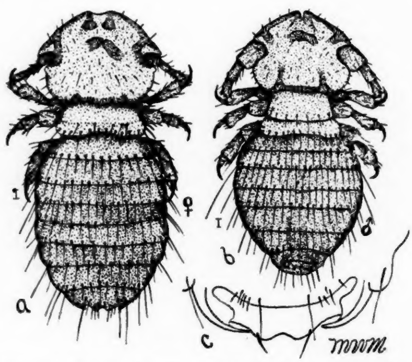
Trichodectes californicus Chapman. Female: Length, 1.37 mm.; width, .84; head, .33; thorax, etc., not given. Form "short, broad, pale yellowish white without definite markings, except on the front of the head." "Head" with "anterior margin with a deep incision; sides of the front receding rapidly to the sharply angulated trabeculæ; .... antennæ long and large, reaching beyond the temporal margin when extended back; ... eye prominent; .... occipital margin nearly straight and without hairs or spines; ....

prothorax long and wide; sides slightly rounding; posterior margin medially convex; .... abdomen broadly oval, reaching its greatest width at the third segment; ...." Chapman ('97). Male not known. From a pocket-mouse, *Perognathus, sp.*



T. californicus. Female. From Chapman, *Ent. News*, ('97).

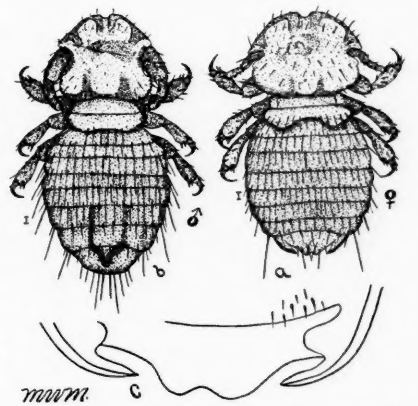
Trichodectes castoris Osborn. Female: Length 1.20; width, .52; head, .32; thorax, .16; antenna, .19. Head broader than long. Antennæ slender, basal joint not swollen. Thorax not showing the suture distinctly. Thorax short, posterior border concave. Abdomen elliptical, widest on segments 4 and 5. Sides straight. Setæ long and delicate on the posterior lateral borders of the segments, shorter on the middle of posterior border. Tarsal claws short and delicate. Male: Length, .99; width .48; head, .21; thorax, .126; abdomen, .252. General shape as in the female. Antennæ longer, with proximal segments swollen. Suture in the thorax more distinct. Abdomen broadest on the third segment, whence the sides converge posteriorly. Setæ on the abdomen long. Genital hooks well developed, lying parallel with one another, but slightly curved. From the Beaver.



T. castoris. *a*, female; *b*, male; *c*, abdominal appendage of female.

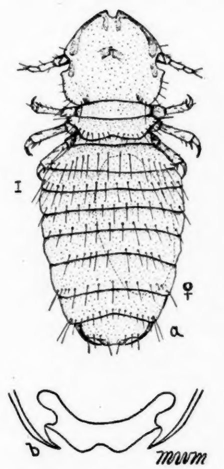
Trichodectes mephitidis Osborn. Female: Length, .90 mm.; width, .50; head, .30; thorax, .12; antenna, 18. Form short and thick. Head broader than long and as wide as abdomen. Antennæ thick, segments equal in diameter. Thorax short and wide, prothorax narrower than remainder of thorax. Metathorax with antero-lateral angles extended. Abdomen thick

and broad, widest on 4. Setæ long and delicate. Tarsal claws of medium size. Male: Length, .90 mm.; width, .46; head, .27; thorax, .18; antenna, .19. Shape as in the female except that the front of the head is more acute. Antennæ longer than in female, with proximal joint swollen. Thorax longer, narrower than in female. Abdomen widest on segments 3 and 4. Setæ long and delicate as in the female. On the Skunk, *Mephitis mephitica*, Ia. and Neb.



T. mephitidis. *a*, female; *b*, male; *c*, abdominal appendage of female.

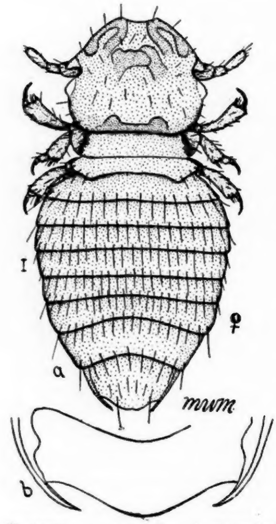
Trichodectes thoracicus Osborn. Female: length, 1.183 mm.; width, .576; head, .324; thorax, .144; antenna, .180. Head broad. Antennæ filiform. Thorax with two parts well distinguished by suture. Lateral border of meso-metathorax widely extending. Posterior border of thorax concave. Abdomen ovate, widest at segments 2 and 3, converging very gently towards the posterior end of the abdomen. Setæ slender and long. Abdominal appendage with flaps provided with extensions toward median line of the abdomen. Male: Length, 1.15 mm.; width, .58; head, .32; thorax, .18; antenna, .21. Head more elongated than in the female. Thorax and abdomen as in the female, save that the abdomen converges more abruptly posteriorly. Proximal joints of the antennæ enlarged. On *Bassaris astuta*, Palo Alto, California.



T. thoracicus. *a*, female; *b*, abdominal appendage of female.

Trichodectes nasuatis Osborn. Female: Length, 1.44 mm.; width, .792; head, .432; thorax, .180; antenna, .234. Head broad, narrower than the abdomen. Antennæ slender, proximal segment slightly enlarged. Thorax short, posterior border concave. Abdomen wide anteriorly, converging from segment 3 to the posterior end. Setæ long and delicate. Tarsal claws long and slender. From Nasua, Costa Rica.

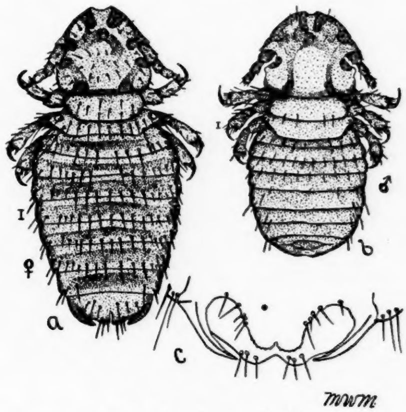
Trichodectes latus Nitzsch. Female: Length, 1.890 mm.; width, 1.116; head, .414; Thorax, .27; antenna, .2888. Head wider than long, front margin flattened-convex, arching forwards but slightly from the antennæ. Eyes prominent. Posterior border of the head as well as the postero-lateral border provided with six long setæ on either side. Antennæ of moderate thickness and length, terminated by a tuft of delicate setæ. Antennal sulcus moderately wide. Prothorax well differentiated from the remainder of the thorax by the suture. Prothorax the length of the meso-metathorax, sides diverging from the attachment with the head, posteriorly, to meet the expanded antero-lateral knob-like expansion of the meso-metathorax. Posterior margin of the thorax emarginate on the abdomen. The abdomen wider than the head, without transverse bands on the segments. Setæ in general long and delicate. Genetalia the type of *Retusus*, but the delicate inner border



T. nasuatis. *a*, female; *b*, abdominal appendage of female.

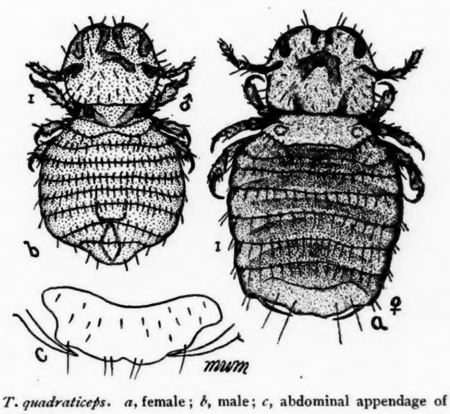
T. latus. *a*, female; *b*, male; *c*, female abdominal appendage.

wider and sinuous. The strong spines of the forward portion of the genitalia point in a postero-median direction as well as outwardly as in *Retusus.* Male: Length, 1.638 mm.; width, .810; head, .414; thorax, .27; antenna, 36. Antennal sulcus very wide. Eyes less prominent than in the female. Antennæ with the basal joints swollen. Abdomen pointed posteriorly. Genital hooks situated close to the median line, but slightly curved. On the Domestic Dog.



T. retusus. *a*, female; *b*, male; *c*, abdominal appendage of female.

Trichodectes retusus Nitzsch. Female: length, 1.206 mm.; width, .576; head, .324; thorax, .162; antenna, .162. Small, head narrower than the abdomen. Sides of head, in front of antennæ, converging anteriorly, the contour of the clypeus being a semicircle. Trabeculæ prominent. Eyes inconspicuous. Antennæ chitinized, strong. Distal segment of the antenna clavate and provided with a wart-like inner extension. Thorax with suture definite. Mesothorax with lateral angles widely expanded provided with strong setæ. Hind border of thorax concave. Abdomen widest on the second segment, whence the borders converge gently to the end of the abdomen. Setæ long and delicate, well distributed. Tarsal claw short and delicate. Tibia with distal angles expanded. Male: Length, .828 mm.; width, .450; head, .288; thorax, 144; antenna, 180. General shape as in the female. Abdomen shorter, rounded posteriorly; generative organs inconspicuous.



T. quadraticeps. *a*, female; *b*, male; *c*, abdominal appendage of female.

Setæ delicate. Tibia with distal edges expanded as in the female. Tarsal joints small. On the Weasel *Putorius ermineus.*

Trichodectes quadraticeps Chapman. Female: Length, 1.08 mm.; width, .63; head, .324; thorax, .114; antennæ, .18. Head quadrangular, widest along the posterior border. Antennæ slender and long. Thorax short, with metathoracic segment extending laterally. Spiracles prominent. Abdomen wide, much wider than head. Widest portion of the abdomen on the fourth segment. Posterior part of abdomen squarish, the sides but little converging. Generative appendages long and prominent. Male: Length, .918 mm.; width, .54; head, .27; thorax, .126; antenna, .114. General shape as in the female. Abdomen wider in proportion than in the female. Setæ short, delicate and sparse. Tarsal claws long, straight and narrow. On the fox, *Urocyon virginianus.*

NOTES AND LITERATURE.

GENERAL BIOLOGY.

Vernon's Variation.[1]— Mr. H. M. Vernon of Oxford, England, has summarized in a handy octavo volume the most important observations on variation made since the publication of Darwin's great work on *The Variation of Animals and Plants under Domestication.* The book will form a valuable student's manual in the field of general biology. It is clear and concise in style and is remarkably free from technical terms and mathematical formulæ, considering the fact that it deals largely with statistical methods.

It is divided into three parts which treat respectively of "The Facts of Variation," "The Causes of Variation" and "Variation in its Relation to Evolution."

Part I includes a brief explanation of the statistical methods employed in the study of variation, a remarkably clear presentation of the difficult subject of correlated variations, and a discussion of dimorphism and discontinuous variation, in which the ideas of Bateson and de Vries receive special attention.

Part II treats of the effects on organisms of external conditions, such as temperature, light and moisture, a subject discussed more exhaustively by Davenport in his *Experimental Morphology* and by Verworn in his *Allgemeine Physiologie.* Two chapters devoted to blastogenic variations contain, along with much other material, an account of important experiments made by the author in the hybridization of various species of echinoderms. Accepting as probably correct the idea of Weismann that variations which are hereditary are of germinal origin, Vernon believes that the heritage borne by the germ-cell is not at all periods of its existence the same, but that it changes as the germ-cell changes in maturity. Thus when two species of echinoderm are crossed, which ordinarily breed at different seasons of the year, that species impresses its characters most strongly on the offspring which is (at the time the cross is made) nearest the height of its breeding season. This conclusion is based

[1] Vernon, H. M. *Variation in Animals and Plants.* 8vo., ix + 415 pp., 30 figs. New York, Henry Holt and Co., 1903.

on the averages of large series of measurements of hybrid offspring, but is very probably vitiated by the occurrence of artificial parthenogenesis so easily produced in the case of echinoderm eggs. Another series of experiments cited by Vernon in support of his view is hardly more convincing. It consists in experiments made by Ewart with mating rabbits early or late in rut.

"Mendel's Law" is treated as a law of "hybridization" only, its profound significance as a general law of heredity being unnoticed, while the Galton-Pearson "Law of Ancestral Heredity" is treated as *the* law of heredity. To many biologists the evidence for the Mendelian principles is too strong and too clearly counter to the Galton-Pearson law to be thus lightly brushed aside. It also raises a strong presumption against Vernon's idea of a heritage *gradually* changing during the ripening of the sexual products.

Part III, contains a brief survey of a familiar field. Natural selection is recognized as the efficient agency in evolution. Adaptive variations are discussed at some length and the evidence for and against their inheritance are considered. Environment is regarded as directly inducing germinal variation. W. E. C.

PHYSIOLOGY.

Von Fürth's Comparative Chemical Physiology of the Lower Animals.[1] — Perhaps the most important general advance made by physiology in the last ten years has been the inclusion of the lower animals within its field of research. Just as anatomy was immensely illuminated by a thorough investigation of the structure of the lower forms and thus became truly comparative, so physiology will gain a clearer and more certain insight into life processes by a study of these where they occur in greatest simplicity. What has already been done in this direction especially from the chemical standpoint is scarcely accessible to the student except through the original sources of publication for ever so excellent a book as Verworn's General Physiology passes over this subject most superficially. Von

[1] Fürth, O. von. *Vergleichende chemische Physiologie der niederen Tiere.* Jena, Fischer, 1903. 8vo., xiv + 670 pp.

Fürth's very extensive compilation will therefore be a welcome guide in this growing field of research. Although von Fürth's volume marks a new departure, the book is arranged on extremely conservative lines. After a brief introduction, it deals with the chemistry of the blood, respiration, digestion, excretion, animal poisons, secretion, etc., a series of heading that suggest at once the sections of the old-fashioned human physiology. It seems really remarkable that such a classification as this should have been adopted, for if there is one lesson taught by comparative physiology more clearly than any other, it is the non-essential character of the blood. Large groups of the lower metazoa are complete organisms and yet they are without this fluid. Why then should the blood be chosen as a means of introducing the student to the chemical physiology of these lower forms? But aside from this traditional treatment of the sections, the substance of these sections is refreshingly modern, and with their excellent bibliographies they form admirable summaries of many new fields of work. The exhaustiveness of the treatment is well indicated by the subject digestion which covers over a hundred pages and takes up in sequence digestion in the protozoa, sponges, cnidaria, echinoderms, worms, molluscs, crustaceans, and other arthropods, devoting a chapter to each. Such a work as this, despite its defects, must find its way to the hands of every advanced student of animal physiology.

Mind in Nature.[1]— This little book is at bottom an argument for a certain form of vitalism. The author, while admitting the value of the chemico-physical descriptions of movements given by Loeb and other investigators of similar interests and aims, insists that it is impossible to account for those forms of movement which we usually designate as action or conduct on this ground. He believes that there is a gap in the physical series which must be bridged by some such factor as the psychic if a complete description of action (Handlung) is to be given.

The work consists of a careful study of the forms of movement. Reflexes are classified as:

I. Simple.
II. Complex
  1. Synchronous
  2. Metachronous
    a. Homometachronous.
    b. Heterometachronous.

[1] Driesch, Hans. *Die "Seele" als elementarer Naturfaktor. Studien über die Bewegungen der Organismen.* Leipzig, Englemann, 1903. 8vo, vi–97 pp.

The synchronous reflexes are such complex movements of multiple phases as exhibit a rhythm; the metachronous are chain reflexes in which each step serves as a stimulus for the next, of these the homometachronous are coördinated, the heterometachronous uncoördinated.

In his discussion of instinct the author states that only simple stimuli can initiate instinctive movements. By a simple stimulus he means something which is essentially an elementary nature quality; such, for example, are light, motion, heat. The simple stimulus he contrasts with the individualized stimulus, which is appropriate for a certain specialized type of sense organ. In this discussion much credit is given to Loeb for his analyses of instincts.

Attempts are made to get at the meaning of the concepts of neural centres, spontaneity, autonomy, etc. Driesch thinks that the present tendency to do away with the concept of brain centre is as far from being desirable as is the uncritical acceptance of the old notion of such centres.

The chapters on directed movements (taxes), reflexes, instincts, and brain centres serve merely as an introduction to the author's real subject, Activity (Handlung). The analysis of reflexes does not furnish the information necessary for the understanding of action, for in the latter there are characteristics which are not found in the simpler forms of movement. The criteria of action which Driesch presents are the "Individuality of Association" and the "Historical Basis of Reaction." Volitional action differs from directed or reflex movement in that it is infinitely variable; it is not a matter of certain elements of stimulus and response in definite and unchanging relation, but of practical unpredictability. Loeb makes the great mistake of supposing that all movements of the organism can be described in terms of the factors which are common to reflexes. Now, in the opinion of Driesch this is impossible, since in action there is "autonomy"; we therefore have to take into account the associational facts, and in as much as the subjective as such cannot be material for the biologist it is necessary to objectify this factor. For Driesch the objective element which enables one to give a description of action is the "psychoid."

The book well deserves the attention of biologists who are interested in the relations of their science to chemistry, physics, and psychology. The chances are that few will be able to agree with the work as a whole, but this makes it all the more valuable. It is of interest to note that we have here another biological discussion which is

avowedly unmetaphysical. The felt-need to say in the preface that a scientific book is unmetaphysical is good evidence of the increasing interest in philosophic problems among biologists. Furthermore, the author who begins by assuring us that he is not going to be metaphysical usually plunges at once into a discussion of metaphysical problems with a naïveté which delights the technical philosopher. The ever increasing interest in the morphology of concepts is evidenced by Driesch in his attention to the meanings of the fundamental concepts with which he has to deal. However unsatisfactory his general conclusions may be to the majority of his readers, he has succeeded in pointing out certain problems which are worthy of attention.

ROBERT YERKES.

The Biogen Hypothesis. [1]— Chiefly for the purpose of establishing a clear working hypothesis as to the inner changes of the living cell Verworn has attempted to make more precise the biogen hypothesis based on the investigations of Hermann, Pflüger, Ehrlich, Allen and others, and to show the wide application of this to the active processes of cells. Biogen molecules, according to Verworn, occur in the cytoplasm, not in the nucleus of the cell. Unlike albumen molecules, they are ordinarily very labile. The nucleus, though containing none of them, gives out material essential to their changes. The cytoplasm contains in addition to the biogen molecules reserve food materials and oxygen, the latter in weak combination. In hunger the reserve food of the cell is first used and then certain biogen molecules are sacrificed to others. To make good such loss food is appropriated and is made available to the biogen molecules through the action of the enzymes. The stimulation of protoplasm consists in changing its biogen molecules from a state of high lability to one of low lability, a change brought on by oxidation. The recovery to the state of high lability is an assimilative process that requires time, and is represented by the refractive period in many operations during which stimulation is impossible. Thus the stimulability of a mass of protoplasm is a measure of the completions of the assimilative processes which repair the effects of stimulation so far as the biogen molecules are concerned. The hypothesis thus affords a more or less complete history for protoplasmic metabolism.

[1] Verworn, M. *Die Biogenhypothesis.* Jena, Fischer, 1903, 8vo. vi + 114 pp.

ZOÖLOGY.

Animal Classification.[1] — Teachers of elementary zoölogy but more particularly students of this subject are often given to crave a simple classification of animals, and to fill this want Professor Wilder has prepared a synopsis of the chief animal groups. The author has disarmed criticism by his avowal that schemes of this nature are mainly personal, but even in such outlines it is fair to expect consistency and freedom from obvious error. Presumably the part on vertebrates should be best written and yet by a strange coincidence the Vertebrata (p. 39) is the only type to which no general definition is given, and the classes of its gnathostome division are numbered one to six with the omission of four. There is no reason to suppose that the beginner would ever rightly determine, by the artificial key at the end of the book, the groups to which such forms as the bilateral sea-urchins and holothurians belong, for by the tables these must come under " Structure radiate." The statement that follows this, " Parts in 2s " would be a stumbling block to any one who knew what bilaterality was. On the whole this key is so very artificial that it is best used when one knows beforehand where the animal belongs. Defects of the kind pointed out, while of no great importance to the advanced student, are serious matters with the beginner, and render the tables much less useful than they should be.

Hertwig's Manual of Zoölogy.[2] — It is a remarkable fact that Hertwig's Lehrbuch, the best German elementary text-book in zoölogy, has been until recently accessible to the English-reading student only through a partial and imperfect translation. Kingsley's[2] new edition in English based on the fifth German edition will therefore be welcomed by many. A cursory examination of the new volume shows that the American edition is likely to repeat the success of its German forerunner. The translating is remarkably well done and the general form of the book excellent. Here and there exception may be taken to the course chosen by the translator. It would have been better to have used exclusively the English term œcology, which is coming to have a definite meaning, rather than the

[1] Wilder, H. H. *A Synopsis of Animal Classification.* New York, Henry Holt & Co., 1902. 8vo. 57 pp.

[2] Hertwig, R. *A Manual of Zoölogy.* Translated and Edited by J. S. Kingsley, from the Fifth German Edition. New York. Henry Holt & Company, 1902, 8vo., xii + 704 pp., 672 text illustrations.

two terms œcology and biology (pp. 4 and 57), which, though synonyms in German, are far from equivalents in English. The choice of the form for proper names, if not of great importance, would lead in English rather to Vesalius than Vesal (p. 12), a matter in which the reader is given his choice with Galen and Galenius (p. 12). In discussing animal temperature poikilothermous, idiothermous and homoiothermous are used without good reason, so far as we know, for the more usual pœcilothermal, idiothermal, and homothermal. The fact that the volume in its several editions has passed from one century to another has led to some confusion which should have been cleared up in editing; thus while we are correctly told (p. 17) that the cell theory is of the "last century" and that the name Protozoa was given "in the century just closed" (p. 186), the "*Origin of Species*" is described (p. 24) as a "scientific work of this century." The proofreading has been unusually close; on page 13, line 28, *unbiassed* is preceded by a useless dash and on page 435 Cumbarus stands for Cambarus. The presswork and illustrations are as a rule good, though many of the newly introduced, original figures, particularly the half-tones, are too faintly printed. The defects that have been pointed out are insignificant compared with the good qualities of the volume, which deserves immediate acceptance as the best general text-book of zoölogy for the majority of American colleges.

The Neurone Theory and its Adherents.[1] — Since the promulgation of the doctrine of the neurone by Waldeyer in 1891 numerous general estimates of this theory have been advanced by almost all the more noted workers in neurology. These expressions of opinion have almost invariably come from advocates of the theory and have been the means of introducing at most only slight modifications of the general doctrine. Up to the present no single considerable publication has been devoted to a thorough review of the body of evidence brought forward by the neuronists and to a radical and well directed attack on their position. Nissl's *Neuronenlehre* is such a publication.

The first chapter of this work takes up briefly Waldeyer's original conception of the neurone and the modifications that during the last ten years this has undergone. In deciding what the essentials of the neurone theory are Nissl makes one of the clearest and most

[1] Nissl, F. *Die Neuronenlehre und ihre Anhänger. Ein Beitrag zur Lösung des Problems der Berziehungen zwischen Nervenzellen, Faser und Grau.* Jena, Fischer, 1903, 8vo., vi + 478 pp., 2 Taf.

justifiable statements of the subject that has appeared. The neurone theory is in essence the application of the cell theory to the complete interpretation of nervous structures, in that the nerve fibres and the neuropile are to be regarded as outgrowths and integral parts of nervous cells whose bodies are represented by ganglion cells. Thus the question of contact or continuity among neurones is set aside as secondary and the real core of the matter is reached by the declaration just given.

Following the introductory chapter come eleven others devoted each to the exposition and rigorous criticism of the views of some well-known neurologist; among the investigators whose opinions are here analyzed are Edinger, Hoche, von Lenhossék, Van Gehuchten, Ramón y Cajal, Kölliker, Verworn, and His. The line of criticism which pervades this part of the book consists in pointing out the fallaciousness of the Golgi method and the failure on the part of the neuronists to appreciate the full significance of the neuropile. The Golgi method is notorious for incompleteness in its impregnations and yet observations based upon it have been used again and again in support of the idea that the neuropile is at least physiologically separable into discrete portions referable to given neurones. Since we know so very little about the structure of the neuropile it would seem, as Nissl rightly urges, that to pass it over simply as a terminal outgrowth of the neurone, or to ignore it almost entirely, as Verworn does, is wholly unjustifiable. This treatment is all the more reprehensible because there is good reason to believe that the neuropile may be the most important physiological element in the whole nervous mechanism.

The concluding chapters, eight in number, serve to develop Nissl's own views as to the structure of the nervous system. These are based largely upon the work of Apáthy and Bethe and centre chiefly about the neuropile. The fibrillar network of the central gray, the invasion of ganglion cells by the neurofibrillæ, and the relation of these to the pericellular Golgi network are discussed in much detail. The scheme of nervous mechanism that Nissl constructs from recorded facts is certainly in many particulars inconsistent with the neurone doctrine. This doctrine was a happy suggestion as to the relations of cells and fibres, but subsequent work on the nervous system has shown that these elements are quite secondary and that the real nervous material is the neurofibrillæ. Since the neurone theory does not touch these and since we know so little about their anatomy and nothing whatever about their development, speculation

should be abandoned together with the insufficient neurone theory, and facts concerning the neurofibrillæ should be sought. This in general is Nissl's position and it will probably carry to the mind of the neuronist the conviction that if this is a fair example of what the neurone theory will have to meet, that theory is still very safe.

Notes. — The earliest stages in the development of the teeth in selachians have been investigated by Laaser (*Jena. Zeitschr. f. Naturwissench*, Bd. 37, pp. 551–578), who finds that in embryos of Spinax, Acanthias, and Mustelus of three to four centimetres in length, a dental ridge is formed by a thickening of the epithelium of the jaws. The ridges are formed earlier in the lower jaws of Spinax and Acanthias and in the upper jaw of Mustelus. Teeth develop not only in the dental ridges but also in the adjacent epithelium where in their early stages they are indistinguishable from placoid scales. The first hard part formed is the dentine, the enamel being entirely absent at these early stages.

Professor Bastian (London, Williams & Margate. Pt. II. 1902, pp. 63–147, pls.) presents in a second installment much additional evidence in favor of his views on heterogenesis. Thus he believes he has shown that vorticellae may be produced from a pellicle largely composed of spirilla, that amoebae may be made to segment and their parts be converted into ciliate infusoria, that the entire egg of the rotifer Hydatina can be transformed into a ciliate infusorian Otostoma, etc. The paper is illustrated by photographic reproductions but even these cannot shake the conviction of many zoölogists, that because of the methods used something is probably wrong with the observations recorded in the text.

Dr. J. Anglas has published as number 17 of the biological series of "*Scientia*" a clear account of the changes undergone by the tissues during the internal metamorphosis of insects. The histogenesis of early development is first taken up, then the process of histolysis, and finally the reconstructive processes. The book contains a final chapter on the causes of internal metamorphosis.

The origin and classification of leucocytes and a very readable discussion of the theories of their relations to health and disease have been published in the biological series of "*Scientia*" numbers 15 and 16 by Dr. J. Levaditi.

Fischer (*Jena. Zeitschr. f. Natur wissensch*, Bd. 37, pp. 691–726) has

made a thorough-going embryological study of the carpus and tarsus of the problematic mammal Hyrax. Since in the embryo the hind foot shows traces of the first and fifth digits, the extremities of Hyrax point to derivation from a primitive form with five digits. The embryonic carpus contains two centralia like the embryonic carpus of the turtle. Traces of both prepollex and prehallux were found. The carpus and tarsus of Hyrax must have been derived from a more primitive form than Phenacodus. Since they show as many affinities to the rodents as to the fossil ungulates, Hyrax has probably been derived from some form in which these two types were united, the Toxodontia, or possibly the more primitive Tillodontia.

The growth of micro-photography has been so rapid that the A B C of the subject has been issued in a handy volume by W. H. Walmsley (N. Y., Tennant & Ward, 1903. iv–155 pp., 13 pls.). Chapters are devoted to the microscope, the camera, illumination, negative making and printing. The experience of an expert, the high quality of whose work is attested by the illustrations that accompany the volume, is given freely to the beginner.

BOTANY.

Setchell and Gardner's N. W. Algæ.[1]— This is a careful and thorough account of the marine Algæ of the Pacific coast of America from Cape Flattery north to the Arctic Ocean, and of the fresh water species found near the shore through the same range, the Diatomaceæ and Desmidiaceæ excepted. The information hitherto accessible has been scattered through many books and papers in various languages, and this is now brought together, but covers only the smaller part of the present work, the rest being now presented by the authors for the first time. This is specially the case as to the fresh water Algæ, in regard to which very little indeed is on record previous to this work.

Every species mentioned by previous writers is included in this list, even if the authors consider the determination as unreliable, or that

[1] Setchell, W. A. and Gardner, N. L. Algæ of Northwestern America. Univ. Cal. Publications, Botany, Vol. 1, pp. 165–418; Pl. XVII–XXVII. Berkeley, March 31, 1903.

the plant in question is to be included under another name here; this makes the total number of species to be credited to the Flora somewhat uncertain; but leaving out about 50 forms, which may be considered as erroneously or uncertainly reported, the following species or named varieties and forms will approximately represent the extent of the Flora.

	Fresh water.	Marine.
Cyanophyceæ	99	26
Chlorophyceæ	65	76
Phaeophyceæ	1	147
Rhodophyceæ	9	214
Total	174	463

This is really a much richer list than any one had before supposed probable; the proportion of Cyanophyceæ is exceptionally large, comparing well with the same order in regions which have long been studied by resident botanists. Dr. Setchell is well known as a specialist on the Cyanophyceæ, and in the expedition along the coast of Alaska recognized many forms which would probably be overlooked by most collectors. The Laminariaceæ are also well represented, and to Dr. Setchell is due the clear presentation and arrangement of these perplexing plants.

It is interesting to compare the Flora of the northwest coast with that of the northeast coast of America. Comparatively few marine species are common, but the proportion increases as we go north, and the common species are mostly found also in northern Europe, indicating a common arctic origin for all the high northern floras, apart from this element there are a few cosmopolitan species, common to both sides of the continent. A few species are common to the Flora of eastern Asia, and a few are common to the European Flora but not found on the west side of the Atlantic; the remaining species, about half of the whole, in the case of the red Algæ more than half, are, as far as known, limited to the Pacific coast of the United States. As regards the fresh water Algae, the case is quite different; nearly all the species are cosmopolitan, some in all latitudes, some in temperate regions only; very few are limited to this region; it is interesting to note that most of the cosmopolitan marine species are of the Cyanophyceæ and Chlorophyceæ, orders more largely fresh water than marine. It is probably accidental that the four species of Characeæ, all European, are reported from Alaska only, in the extreme North.

In the introduction the authors divide the entire west coast into four quite well marked regions of algal growth; the Tropical, the North Subtropical, the North Temperate and the Boreal; with the suggestion that further study may make it necessary to divide the latter into an Upper and a Lower Boreal. The approximate boundaries are Magdalena Bay, Lower California; Point Conception, California, and Puget Sound. The present work includes such of the Temperate element as appears in Puget Sound, and the whole of the Boreal. The subtropical families Valoniaceæ and Dictyotaceæ are each represented by a single species. If the division of the Boreal into upper and lower is adopted, each of these regions corresponds to a range of surface temperature, there being a variation of 5° C. as we pass from one to another; each region having approximately a difference of 5° C. between the maximum and the minimum. The division between the upper and the lower Boreal has an isochryme of 5° C. and an isothere of 10° C. the southern limit of the North Temperate having 20° C. and 25° C. respectively.

As is to be expected from the latitude, the great Laminariaceæ are the most conspicuous element of the Flora; this region probably exceeds all others in the gigantic size of the individuals and the variety of forms of this family. The genus Alaria is represented by eighteen species and forms, one of which, *A. fistulosa*, has a blade reaching a length of 25 meters. The eighteen different genera of Laminariaceæ form a very rich representation of the family. Lithothamnion and the allied genera are well represented, comparing favorably with other northern regions; while the jointed Corallinaceæ have many forms, contrasting strongly with the single species found on our Northeast coast.

While many individual collectors at various points have contributed to this work, the greater part of the material on which it is founded was obtained by the expedition from the University of California, in the summer of 1899, on which Professor Setchell was accompanied by W. L. Jepson, L. E. Hunt and A. A. Lawson; while it is certain that additions will be made to the list by future explorers, the general character of the marine Flora may be considered as fairly well established.

The arrangement follows the system of Engler & Prantl in the main; as to nomenclature, a very conservative course has been followed, generic names long in use being retained, no effort having been made to replace them by earlier but neglected or abandoned

names; nor have specific names been changed unless the change was unavoidable. "We have preferred to devote our time to the study of the plant itself" the authors say, and certainly if the choice had to be made, they have chosen wisely. We have an ample supply of botanical literature, affixing the author's name to new binomials, representing plants that the author would never recognize if he met them. The authors of this work know their plants thoroughly, and those who enjoy juggling with names, can do it at their leisure.

In the matter of specific limitations, there is quite a tendency to broaden out a species, and give form names to what others would consider autonomous species; not less than 142 "formæ" being named in this work, some representing former species, some being newly distinguished. Laminaria, Alaria and Fucus give good examples of this practice; but perhaps the most striking are in Corallina and Amphiroa; here the disappearance of former species is quite startling. Two new genera, Whidbeyella and Collinsiella are proposed, and nine new species; the authors propose nothing as a variety, recognizing the term only as used by other authors. Descriptions of new species and forms are full and clear; there are eleven good plates; the type and paper are excellent. Specimens are referred to by collectors or exsiccatae members; there is a good index, and a very full list of the literature of the subject. Exact localities are given in almost every case, and there is an alphabetical list of all the localities mentioned, with full indication of the latitude, longitude, etc., of each; this novel feature is contributed by Professor George Davidson of the University of California.

No work of such general importance to this department of American botany has appeared since Harvey's *Nereis Boreali-Americana*, fifty years ago; and while undoubtedly much will be added by the subsequent studies of the active botanists who are doing such good work on the west coast, it is unlikely that there will ever be any one contribution that will contain as much new information as does this. The authors deserve the thanks of all students of Algæ.

FRANK S. COLLINS.

Notes.— The *Proceedings of the Society for the Promotion of Agricultural Science*, for the 24th meeting, contain the following articles of botanical interest: Jones and Sprague, "Plum Blight caused by the Pear Blight Organism"; Saunders, "Some Results of Cross Fertilizing," and "Decrease in Vitality of Grain by Age"; Fernow, "The Significance of the Farmer's Woodlot"; Pammel and Lum-

mis, "The Germination of Weed Seed," and "Germination of Maize"; Lummis, "Effect of Coal Tar, Coal Oil, Gasoline, Benzine and Kerosene on Germination of Maize"; and Lazenby, "Composition and waste of Fruits and Nuts."

The American Botanist for May contains the following articles: Dobbins, "Lycopodiums of the Green Mountains"; Gilbert, "A New Fern from Bermuda [*Asplenium muticum*]"; Ryon, "Poison Ivy and its Effect"; and Barrett, "Deciduous Tropical Trees." — The editor's "Botany for Beginners," and a series of notes, constitute a prominent feature of the number.

A new journal, *Annali di Botanica*, under the direction of Professor Pirotta of Rome, has been started. The first number, dated May 15, contains articles on the development of the seed of Cynomorium, description of a new Euphorbia, *E. Valliniana*; a study of the influence of climate and location on the structure of plants in the Mediterranean region; a study of the origin and differentiation of the primary vascular elements of the roots of Monocotyledons, and notes on Gherardo Cibo's herbarium and on a recently unearthed addition to the herbaria of Liberato Sabbati.

The *Botanical Gazette* for June contains the following articles: Sargent, "Cratægus in Northeastern Illinois"; Stevens, F. L. and A. C., "Mitosis of the primary Nucleus in *Synchytrium decipiens*"; Bergen, "The Macchie of the Neapolitan Coast Region"; Butters, "A Minnesota Species of Tuber"; West, "A new botanical Research Laboratory in the Tropics"; and, Ashe, "New or Little-Known Woody Plants."

The *Bulletin of the Torrey Botanical Club* for June contains the following articles: Harper, "Botanical Explorations in Georgia during the Summer of 1901, II Noteworthy species"; Bush, "A list of the Ferns of Texas"; Eaton, *Isoetes riparia Canadensis* and *I. Dodgei*."

The *Journal of Mycology* for May, with portrait of S. M. Tracy for frontispiece, contains the following articles: Blasdale, "A Rust of the Cultivated Snapdragon"; Morgan, "A new species of Sirothecium"; Seymour, "A Series of Specimens Illustrating North American Ustilagineæ"; Morgan, "Dictyostelieæ or Acrasieæ"; Murrill, "Historical Review of the Genera of Polyporaceæ"; Durand, "The genus Sarcosoma in North America"; Ellis and Kellerman, "Two new Species of Cercospora"; Kellerman, "Another much-named

Fungus"; "*Puccinia lateripes* an Aut-Eu-Puccinia"; "Alternate Form of *Aecidium hibisciatum*"; "Ohio Fungi, Fascicle VII"; "Index to North American mycology"; "Notes from mycological literature, V"; and editor's notes.

The 18th volume of the *Transactions of the Kansas Academy of Science* contains the following articles of botanical interest: Sayre, "Loco Weed"; Gould, "Notes on the Trees, Shrubs, and Vines in the Southern Part of the Cherokee Nation"; Garrett, "A provisional List of the Uredineæ of Bourbon County, Kansas"; and Smyth, "Preliminary List of medicinal and economic Plants in Kansas."

The eleventh *Annual Report of the Ohio State Academy of Science* contains short papers or abstracts on a number of botanical subjects.

The *Popular Science Monthly* for July contains the following articles of botanical interest: Cook, "Evolution, Cytology and Mendel's Laws"; and Zirngiebel, "The Preservation of Wild Flowers.

The *Plant World* for June contains the following articles: Safford, "Extracts from the note-book of a naturalist on the Island of Guam, VII"; Beattie, "Indian Hemp as an ornamental"; Williams, "A collecting Trip to Bolivia"; Orcutt, "Uses of Cacti"; Mansfield, "[*Osmunda regalis*]"; and Shear, "Fungi on old Logs and Stumps."

Rhodora for June contains the following articles: "The identity of *Iris Hookeri* and the Asian *I. setosa*"; Sargent, "Recently recognized species of Cratægus in Eastern Canada and New England, IV"; Bissell, "A new station for *Dentaria maxima*"; Harvey, "*Splachnum ampullaceum*"; Evans, "Preliminary lists of New England plants, XI, Hepaticæ"; Bissell, "*Galium erectum* and *Asperula galioides* in America"; Fernald, "Some variations of *Triglochin maritima*"; and, Robinson, "A hitherto undescribed Pipewort from New Jersey [*Eriocaulon Parkeri*]."

Torreya for June contains the following articles: Cockerell, "Notes on New Mexico Oaks"; Earle, "A Key to the North American Species of Panus"; Harper, "A new Arabis from Georgia"; Gleason, "A second Illinois Station for *Phacelia Covillei*"; Harper, "*Lycopodium cernuum* in Georgia"; and, "Britton, A new Species of Urera [*U. magna*]."

Zoe for May contains the following articles: Brandegee "Flora of the Providence Mountains," "Vegetation of the Colorado Desert,"

"Notes and New species of Lower California plants," and "Notes on Papaveraceæ." The number closes with a facetious review of an entertaining recent publication on California botany.

As the opening number of Volume VIII of the *Contributions from the United States National Herbarium*, Dr. Rose publishes a third part of his "Studies of Mexican and Central American Plants," marked by his usual critical acumen. It is to be hoped that in the various readjustments of the Government publication facilities, these Contributions from the National Herbarium may not be neglected.

Part VI of Captain J. D. Smith's "Enumeratio plantarum Guatemalensium necnon Salvadorensium Hondurensium Nicaraguensium Costaricensium," recently issued, consists of 87 octavo pages of herbarium label records of recently collected Central American plants.

Fascicle 3, completing the 3rd volume, of Urban's *Symbolæ Antillanæ*, issued in May, contains descriptions of miscellaneous genera and species, by Urban, accounts of mosses, by Brotherus, Burmanniaceæ, by Urban, Ficus, by Warburg, Cruciferæ, by Schulz, and Selaginellæ by Hieronymus.

A most valuable scientific treatise on the Bermudas, with an extensive bibliography, by Professor Verrill, forms the second part of the centennial volume, Volume XI, of the *Transactions of the Connecticut Academy of Arts and Sciences*, which is very fully illustrated by text cuts and plates.

The economic grasses and forage plants of Idaho are the subject of a paper, by Henderson, published as *Bulletin No. 38* of the Agricultural Experiment Station of the University of Idaho.

Notes on Faulkland Island plants, collected by Vallentin, are contained in the *Memoirs and Proceedings* of the Manchester Literary and Philosophical Society, vol. XLVII, pt. 3.

A lecture on the spring flora of Table Mountain, at the Cape of Good Hope, by Engler, is issued as Appendix II to the *Notizblatt* of the Berlin Botanical Garden, under date of April 1st.

Volume II, Fascicle 4, of Coste's *Florè descriptive et illustrée de la France* is devoted to a continuation of the Compositæ.

A revision of Chironia, by Schoch, is distributed as no. 19 of the

Mitteilungen aus dem Botanischen Museum der Universität Zürich, from the *Beihefte zum Botanischen Centralblatt*.

The species of Cratægus occurring about Rochester, New York, are discussed by Sargent in a number of the *Proceedings of the Rochester Academy of Science*, issued in June.

The species of Cratægus of Northeastern Wisconsin are discussed by Schuette in the *Proceedings of the Biological Society of Washington* of June 25th.

A preliminary paper on a natural arrangement of the species of Ribes, by Janczewski, is issued as an extract from the *Bulletin international de l'Académie des Sciences de Cracovie, Classe des Sciences mathématiques et naturelles*, for May.

A new Solidago from the Yukon region is described by Gandoger in the *Bulletin de la Société Botanique de France*, issued on the 25th May.

An interesting economic study of the species of Orobanche found in the United States, by Garman, is published as *Bulletin No. 105* of the Kentucky Agricultural Experiment Station.

An excellent photogram of *Yucca glauca* accompanies an article on the use of Yuccas for planting on sand dunes, in *Arboriculture* for June.

Fletcher publishes, in the *Ottawa Naturalist*, for June, some notes on teratological specimens of *Trillium grandiflorum*.

An illustrated article on the Redwood is published in *Forestry and Irrigation* for June.

Dr. Davis' paper on Oogenesis in Saprolegnia, printed in the *Botanical Gazette*, has been included also in the *Decennial Publications* of the University of Chicago, and issued in separate form under date of March 1, 1903.

A monograph of the Uredineæ of Umbelliferæ, by Lindroth, has been separately issued from Volume 22 of the *Acta Societatis pro Fauna et Flora Fennica*.

An addition to our knowledge of the fungus which occurs in the caryopsis of Lolium, and to which the poisonous properties of the latter have been attributed, is contributed, by Freeman, to the *Philosophical Transactions of the Royal Society of London*, Volume CXCVI.

An attractive little treatise on the poisonous mushrooms of Europe, with particular reference to France, accompanied by a wall chart illustrating eight deadly or dangerous species, by Octave Grosjean, is published by the author at Saint-Hilaire, near Roulans, France.

The root rot of the sugar-cane forms the subject of a thick quarto volume, by Kammerling, published by van Ingen, of Sœrabaia, Java.

From experiments conducted with the colon bacillus, Professor Jordan concludes, in a paper on The Self-purification of streams, reprinted from Volume X of the *Decennial Publications of the University of Chicago*, that the enteric bacteria disappear almost completely in less than 150 miles in a river like the Illinois.

A set of photomicrographs, accompanied by explanatory text, illustrating the effects of *Pseudomonas campestris* on the turnip, are published by E. F. Smith as *Bulletin No. 29* of the Bureau of Plant Industry of the United States Department of Agriculture.

Sydow's *Monographia Uredinearum*, in its third fascicle, reaches No. 879 of the species of Puccinia.

From an article by Leffmann, in the June *Journal of the Franklin Institute*, it appears that Agar-Agar is considerably used in certain grades of ice cream and jelly, and its use is said to be capable of easy detection by means of Arachnodiscus and other diatoms which are always found on it, even in prepared food articles.

Several important fern papers are contained in the *Annals of Botany* for June.

The dehiscence of the sporangium of pteridophytes is further discussed by Steinbrinck in the *Berichte der deutschen Botanischen Gesellschaft*, issued May 27th.

The relations of the leaf bundles of Conifers to the thickening of the stem are discussed by Tison in Volume II of the *Mémoires de la Société Linnéenne de Normandie*, which also contains an article by Lignier on the fruit of *Williamsonia gigas* and the Bennettitales.

The *Irish Naturalist* has recently been giving considerable space to a discussion of the leaf markings of *Arum maculatum*.

Observations on the digestion of proteids with papain, by Mendel and Underhill, are published in Vol. XI, part 1, of the *Transactions of the Connecticut Academy of Arts and Sciences*, recently distributed.

The formation of oxalic acid in green plants is discussed by Benecke in Heft 5, Abt. I., of the *Botanische Zeitung.*

Professor Davis considers the evolution of sex in plants in the *Popular Science Monthly* for February.

The upper temperature limits of life are discussed by Professor Setchell in *Science* of June 12.

An account of a new myrmecophilous plant, *Macaranga triloba*, by Smith, is published in *The New Phytologist* of May 30th, which also contains a number of other interesting morphological and ecological papers.

A practical lecture on The use of timber by railroads and its relation to Forestry, by von Schrenk, is published in the *Official Proceedings of the New York Railroad Club*, for May, and is followed by an address by Professor Fernow on railroad interests in forest supplies, and a discussion of the subject.

A discussion of the Seasoning of timber, by von Schrenk and Hill, constitutes *Bulletin No. 41* of the Bureau of Forestry of the Department of Agriculture.

Economic seedling studies of *Lilium harrisii*, by Oliver, are published as *Bulletin No. 39* of the Bureau of Plant Industry of the United States Department of Agriculture.

Economic notes on *Edgeworthia papyrifera*, *Aralia cordata* and *Eutrema wasabi*, by Fairchild, form *Bulletin No. 42* of the Bureau of Plant Industry of the United States Department of Agriculture.

Professor Halsted's report on the botanical department of the New Jersey Agricultural College Experiment Station, for 1902, contains a number of articles on plant breeding and selection, the behavior of mutilated seedlings, and parasitic fungi.

A study of Northwestern apples, by Hansen, constitutes *Bulletin 76* of the South Dakota Experiment Station.

The teaching of botany in secondary schools is discussed by several writers in the *Journal of Applied Microscopy and Laboratory Methods* for June.

An account of the Department of Botany of Columbia University and its relation to the New York Botanical Garden, by Underwood, is published in the *Columbia University Quarterly* for June.

According to a note by Hemsley in *Nature* of May 21, the Kew herbarium is now estimated to contain considerably more than 2,000,000 specimens, attached to 1,300,000 sheets, — and its greatest value is qualitative rather than quantitative.

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